AN EXAMINATION OF THE LANGUAGE OF PSYCHOPATHS: DIFFERENCES IN PROSODIC CHANNELS OF COMMUNICATION IN PSYCHOPATHIC AND NON-PSYCHOPATHIC OFFENDERS

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Natural speech contains a wealth of information relevant to understanding cognitive and affective psychological processes, which are reflected in both prosodic and semantic channels of communication. While differences in semantic channels have been demonstrated among psychopathic versus non-psychopathic individuals, research on the role of prosody in psychopathy is scant. The Computerized Assessment of Natural Speech protocol provides adetailed assessment of macroscopic-level prosody variables related to underlying psychological processes that have been linked to psychopathological conditions. Psychopathy is a condition that involves a number of disruptions in cognitive and affective processes, which theoretically can be tied to various aspects of speech. The present study provides a novel contribution by examining natural speech output in an offender sample in the context of a clinical interview (Psychopathy Checklist – Revised). More specifically, the present study examined variance in prosody across segments of the PCL-R interview designed to elicit both positively and negatively valenced emotional content, across high and low levels of subjective arousal, in psychopathic (n = 49) and non-psychopathic (n = 44) male offenders who were similar in terms of age, education, race/ethnicity, and IQ. Three-factor mixed MANOVAs (Group x Valence x Arousal) were conducted to evaluate differences in prosodic speech displayed by the offenders. Results indicated significant interactions between psychopathic and non-psychopathic offenders across valence and arousal conditions in terms of percentage of silence, average pause length, longest pause length, average within-utterance variation in subjectively defined pitch and articulation variables, and average rate of change in articulation across speech sample. Implications and future directions for research are discussed.

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CHAPTER 1

INTRODUCTION

Assessment of Natural Speech

The study of verbal behavior represents a long-standing tradition in psychological research. Support for conceptualizing psychological constructs through language can found in the theory of *cognitive constructivism*, which posits that internal emotional experiences are coded as schemas in forms of semantic representations (Beck et al., 2004). The process of constructing these affective schemas is closely related to language production. As such, the empirical study of language may provide valuable insight into understanding an individual's inner affective experience (Gawda, 2010). Typical methodologies utilize lexical analysis (i.e., the study of linguistic style), which is used to assess verbal behavior and expression through the specific types of words used, without consideration of the narrative context in which the speech occured (Pennebaker & King, 1999; Pennebaker, Mehl, & Neiderhoffer, 2003). This quantitative approach to assessment of verbal behavior involves computer software that conducts a word count of a given transcribed speech sample and sorts them into word categories, based on a previously established dictionary (Pennebaker & King, 1999; Junghaenel, Smyth, & Santner, 2008). As such, linguistic analysis affords researchers a unique opportunity to conceptualize psychological characteristics, such as insight into overall psychological functioning, personality, and affective experience, beyond the scope of traditional self-report or clinician-rated measures (Hancock, Woodworth, & Porter, 2013; Oberlander & Gill, 2006; Pennebaker, Mehl, & Niederhoffer, 2003).

The utilization of linguistic analysis in psychology has been traditionally used in the study of psychopathology and normal range personality (Junghaenel, Smyth, & Santer, 2008).

Differences in linguistic style relevant to psychopathology and normative dimensions of personality have been noted in subclinical, undergraduate, and community samples. For example, increased usage of first-person singular pronouns is indicative of suicidal ideation in poets (Stirman & Pennebaker, 2001) and vulnerability to depression in college students (Rude, Gortner, & Pennebaker, 2004). In a sample of undergraduates, Cohen and colleagues (2008) found that trait positive affect and behavioral activation systems were related to increased use of positively valence words, while trait negative affect and behavioral inhibition systems were related to increased use of negatively valenced words. Junghaenel and colleagues (2008) found that when compared to healthy comparisons, writing samples of psychiatric inpatients contained significantly fewer references to bodily and somatic concerns, optimism, the future, basic cognitive functions, and communication with others. Furthermore, a progressively decreased use of negatively valenced emotion words and increased use of positively valenced words has been shown in the speech of outpatients recovering from depression, illustrating the utility of linguistic analysis in assessing treatment efficacy (Pennebaker, Mehl, & Neiderhoffer, 2003). Further, psychiatric inpatients with elevations in alexithymia (i.e., difficulties in expressing and identifying emotional states in oneself and others) show decreased use of both positive and negatively valenced affectively-charged words, (Tull, Medaglia, & Roemer, 2005), while inpatients with schizophrenia demonstrate abnormally elevated use of negatively valenced words across both positive and negative situations when recounting emotionally charged memories (Cohen, Minor, Baillie, & Dahir, 2008).

While previous research utilizing methods of linguistic analysis has typically focused on writing samples, another viable approach for understanding psychological constructs through language is to characterize aspects of vocal communication through natural speech samples.

Vocal communication is not only a crucial mechanism for the exchange of both explicit and implicit information between individuals, but also serves as an indicator of a person's affective and cognitive state (Cohen, Dinzeo, Donovan, Brown, & Morrison, 2015; Cohen, Renshaw, Mitchell, & Kim, 2016). More specifically, evidence suggests that affective and cognitive states can influence dysfunction in vocal communication, indicating a complex reciprocal relationship between affect, cognition, and verbal behavior (see Cohen et al., 2016). In a sample of undergraduates, Barch and Berenbaum (1994) found evidence for *cognitive reactivity* in speech such that disturbances in vocal communication (e.g., syntactic complexity, pause patterns, verbosity) increased with difficulty in experimentally-manipulated cognitive load. Furthermore, experimental paradigms designed to evoke negative emotional states have been shown to exacerbate speech disturbances in non-psychiatric controls, providing evidence for *affective reactivity* in speech (Docherty et al., 1998). While increases in negative affectivity exacerbate speech disturbance in patients with schizophrenia, laboratory paradigms designed to induce positive affect have been shown to significantly reduce such speech disturbances (Cohen & Docherty, 2005). More generally, the literature has demonstrated that unique disturbances in vocal communication are seen across a broad range of mental illnesses, including depression, anxiety, and schizophrenia (Cohen et al., 2016). As such, assessments of vocal communication through natural speech provide an important, understudied mechanism to conceptualize psychological functioning in individuals suffering from a variety of psychiatric disorders.

Experimental paradigms utilized to assess vocal communication typically involve digitized samples of natural speech, which are then subjected to computerized acoustic analyses. As discussed, natural speech contains a wealth of information relevant to understanding psychological functioning, which can be conveyed through both *prosodic* (e.g., non-verbal aspects of spoken communication, such as emphasis, inflection, and rate of speech) and *content* (e.g., semantic content of communication) channels (Cohen et al., 2009). Content channels of communication are typically measured using linguistic analysis software, such as the Lexical Inquiry and Word Count (LIWC; Pennebaker & King, 1999). A LIWC analysis often involves use of standardized, non-descript probes to assist in characterizing length samples of written or spoken communication (Cohen, Minor, Najolia, & Lee Hong, 2009). Prosodic channels of communication, on the other hand, are typically measured using acoustic analysis protocols, such as the Computerized Assessment of Natural Speech (CANS) protocol (Cohen et al., 2009).

While computerized assessments of both prosodic and content channels of communication each provide unique insight into psychological functioning, it is important to consider the impact of environmental and individual differences on speech output, as well as which aspects of speech were analyzed when evaluating results. For example, previous studies have found that natural speech varies widely on the basis of a number of contextual and individual difference variables, including affective context of the probe (Batliner, Steidl, Hacket, & Nöth, 2008), arousal (Cohen, Hong, & Guevara, 2010), and cognitive influences (e.g., increased cognitive load, cognitive stress, working memory; see Cohen, Dinzeo, et al., 2015). Furthermore, when considering the output of computerized assessments, it is important to consider whether microscopic or macroscopic aspects of speech were measured (Cohen et al., 2016). *Microscopic* aspects of speech are typically within the realm of traditional acoustic analysis, provide more information on the physical processes involved in speech due to its utilization of brief speech samples, and focus on how anomalies in these physical processes (e.g., motor anomalies) can result in communication disorders (Kent & Kim, 2003). *Macroscopic* aspects on speech, however, utilize extended samples of speech (typically > 30 seconds), and involve aggregate statistics of speech production and variability in speech across samples from a single individual (Cohen et al., 2016). As such, “macro” level approaches can provide more stable assessments of the language phenomena of interest across speech samples (e.g., cognitive deficits; see Cohen, Dinzeo, et al., 2015) and therefore the associated psychological processes relevant to speech (Cohen et al., 2016).

Briefly, “macro” level approaches to speech generally focus on properties of speech, or signals, relevant to both *fundamental vocal expression* (e.g., mean pause and utterance length, intensity, fundamental frequency, first format frequency, second format frequency), as well as *variability of the signal* (e.g., standard deviation of pause and utterance length, emphasis, intonation, articulation) and the *frequency of distinct events* (e.g. number of pauses or utterances) within the sample (Cohen et al., 2009; Cohen et al., 2015; Cohen et al., 2016). See Table 1 for descriptions for macro-level variables. Conceptually, “macro” level variables relevant to speech variability can be related to the clinical construct of blunted affect, while those relevant to speech production (e.g., mean pause and utterance length and frequency) map onto the construct of alogia (Cohen et al., 2013; Cohen et al., 2014). Given the rapid rate of natural speech, as well as the vast array of variables that can be derived from it, computerized analysis has become a useful tool to aid in such research.

Cohen and colleagues (2009) developed the Computerized Assessment of Natural Speech (CANS) as an automated protocol to assess vocal expression from natural speech output by bridging methodologies from both content and prosodic analyses with a focus on macroscopic aspects of speech. The CANS has proven beneficial in laboratory-based research in that the valence, intensity, and modality of the emotion-induction stimuli used can be varied, allowing for a wide range of applications (e.g., sensory modality of emotion-induction stimuli – visual or auditory presentation; positively or negatively-charged valence, high or low arousal induction stimuli). In addition to refined manipulation of emotion-induction stimuli, other conceptually relevant variables to speech production, such as the impact of increased cognitive load, can be concurrently examined (Cohen et al., 2016). The administration of said stimuli can be automated, thus removing sources of error variance (e.g., research assistant error). Furthermore, brief, standardized scripts previously used in prosodic analyses are not necessary using the CANS protocol, thus accommodating both standardized laboratory probes and free verbal expression to examine macro-level aspects of speech.

The CANS protocol has demonstrated its utility in elucidating the impact of the experimental manipulation of psychological processes on the production of natural speech across community adults (Cohen, Dinzeo et al., 2015), undergraduates (Cohen et al., 2009), psychiatric outpatients (Cohen et al., 2016a), and long-term forensic psychiatric inpatients (Cohen et al., 2016b). In a community sample, increased information-processing load, as manipulated by a dual-attention experimental paradigm presented during a speech task, resulted in fewer utterances overall, longer pauses between utterances, greater percentage of silence overall, and less variability in frequency and intensity levels (Cohen, Dinzeo, et al., 2015). The CANS protocol has demonstrated particular efficacy in elucidating the speech patterns of individuals with schizophrenia-spectrum disorders. For example, when compared to non-psychiatric controls, undergraduates with psychometrically-defined schizotypy do not exhibit pathological speech characteristics under increased cognitive load and, somewhat paradoxically, exhibit better performance on high cognitive load tasks than controls (Cohen et al., 2014). However, there is some support that pathological differences in speech characteristics emerge in undergraduates with schizotypy compared to controls when differentially valenced affective memory probe tasks are introduced, such that individuals with schizotypy demonstrated significantly impaired fluency when introduced to pleasant and unpleasant valenced tasks compared to controls (Minor et al., 2015). Furthermore, the CANS protocol has demonstrated its utility in delineating patients with schizophrenia with clinically-rated flat affect from non-flat patients, as well as flat patients from non-flat patients and controls in terms of clinician-rated alogia (Cohen, Alpert, Nienow, Dinzeo, & Docherty, 2008). While the majority of previous studies using the CANS protocol have primarily focused on schizophrenia-spectrum disorders, both the relevant applications to underlying cognitive and affective processes and the methodological flexibility inherent to the task itself lends itself to research on a wide variety of psychopathological conditions. One such form of psychopathology in which there are considerable disruptions in both cognitive and affective domains, as well as disturbances in affect (e.g., callousness, lacking remorse), is psychopathy.

Psychopathy: A Brief History of the Construct and its Assessment

Psychopathy is a clinical construct characterized by a pattern of covert (e.g., deceitful, calloused use of others) and overt (e.g., poor behavioral controls, aggression) antisocial personality traits and tendencies (Hare, 2003; Neumann, Hare, & Newman, 2007; Hare & Neumann, 2008). Psychopathy has been associated with a variety of problematic affective and antisocial external correlates, such as substance and alcohol use (Magyar et al., 2011; Neumann & Hare, 2008; Peters, Greenbaum, Edens, Carter, & Ortiz, 1998), fearlessness and low trait anxiety (Neumann et al., 2012), increased proclivity towards violence (Hare, 2003; Salekin, Rogers, & Sewell, 1996), reactive and instrumental aggression (Hill et al., 2004; Vitacco et al., 2005), and criminal recidivism (Gendreau, Goggin, & Smith, 2002; Olver et al, in press; Salekin, Rogers, & Sewell, 1996).

While the prevalence of psychopathy in the general population is around 1% (Neumann & Hare, 2008), individuals with psychopathy make up 15 to 25% of currently incarcerated male offenders (Hare, 2003). Additionally, offenders with psychopathic traits demonstrate a more severe, persistent pattern of violent offenses, engage in more misconduct and violence while incarcerated, and are more likely to engage in violent offenses with more serious harm to their victims (Edens, Polythress, Lilienfeld,& Patrick, 2006; Hemphill, 2007; Lawing, Frick, & Cruise, 2010; Leistico, Salekin, DeCoster, & Rogers, 2008; Porter & Woodworth, 2006). Given the societal cost that psychopathy poses, research has focused on external correlates and valid assessment of the construct. Modern research on psychopathy has progressed exponentially due to the advent of the Psychopathy Checklist (PCL: Hare, 1985) and its revisions (PCL-R; 1991; 2003). The PCL-R and it modern derivatives have provided reliable and valid assessments of psychopathic personality, as well as an accepted conceptual approach for this area of research by synthesizing seminal clinical observations and theories (e.g., Arieti, 1963; Karpman, 1955; Cleckley, 1976) along with Hare's extensive empirical research on the construct (Hare, 2003).

The PCL-R is a clinical construct rating scale based on information gleaned from a semi-structured interview, extensive file and case history review, and scoring criteria, which is used to rate each of the 20 items on a three-point scale (0 = absent, 1 = subthreshold, 2 = threshold) based on the applicability of the item to the individual being rated. Possible total PCL-R scores range from 0 to 40, with a score of 30 being a common clinical and research cut-off in diagnosing psychopathy. The PCL-R and its derivatives (e.g., Psychopathy Checklist-Screening Version (Hart, Hare & Cox, 1995), Hare Self-Report Psychopathy Scale (SRP; Paulhus, Hare, &

Neumann, 2016) mathematically represent psychopathy as a superordinate construct underpinned by four correlated dimensions capturing manipulative and deceptive interpersonal style (*Interpersonal*), calloused, remorseless use of others (*Affective*), parasitic and impulsive lifestyle orientation (*Lifestyle*), and chronic dissocial attitudes and behaviors (*Antisocial*) that are inherent to the construct. Although initially developed for research purposes, evidence for its utility for the prediction of violence and recidivism has led the PCL-R to become widely adopted for the purpose of forensic assessment (Hare, 2007; Leistico et al., 2007; Quinsey et al., 2006). While the four factors represent the broad syndrome of psychopathic personality, the affective factor is often considered an essential core of the larger theoretical construct, and in modern modeling research, has been shown to be a critical predictor of violent acts (Krstic et al., 2017; Vitacco et al., 2005) As such, the PCL-R represents a critical tool utilized by both researchers and clinicians for the assessment of psychopathy (Neumann & Hare, 2008).

Due to its high stakes implications in forensic settings (e.g., parole decisions), the PCL-R has been subjected to enormous scrutiny with regards to its underlying latent structure, reliability, and validity (Hare & Neumann, 2010). While the PCL-R remains the international standard for the assessment of psychopathy, there are some important considerations regarding its use. As with any semi-structured interview, the PCL-R requires extensive training and skilled researchers and clinicians to administer it. As such, the time and cost to train individuals as well as the low base rate of extreme levels of psychopathy in the general population means there are some practical considerations regarding its use. Thus, researchers have sought to identify additional means of assessing psychopathic features, which could potentially be used to supplement or enhance PCL-R assessments. For example, Fowler, Lilienfeld, and Patrick (2009) demonstrated that lay observers could effectively detect psychopathic features from “thin slices” (i.e., small samples of behavior, taken from audio and video recorded interviews with offenders), with ‘thin slice’ ratings positively associated with expert-derived PCL-R ratings. This study highlights that useful audio and video information exists within digital PCL-R based interviews that can be extracted to further research on the nature of psychopathic personality.

A movement towards objective, automated measures of psychopathology and affective experience, such as computerized assessments of vocal communication, may be a useful adjunct to formal psychopathy assessments, especially for augmenting the assessment of affective propensities in a population that is, by definition, manipulative, glib, and superficially charming in their interactions with others. Such automated measures are not only inexpensive to administer and interpret, but resources necessary to administer computer-based measures are widely available and can provide multiple assessments of individuals in correctional facilities without exorbitant cost. Furthermore, the inclusion of automated, objective measures in the formal assessment of psychopathy offer valuable adjunctive information along with more formal, diagnostic measures and self-report instruments to provide a more complete picture of affective and cognitive functioning in individuals with psychopathic personality. As will be discussed below, research has been moving in the direction of using objective assessments of language processing in psychopathy, and the results suggest further in-depth analysis of language, prosody especially, may be a productive avenue to pursue.

Linguistic Analysis in Psychopathic Personality

The semantic quality of psychopathic speech represents a long-standing area of interest, with a significant focus on emotional expression. In his initial clinical descriptions, Cleckley (1976) described individuals with psychopathy as using “empty language” as a means of exploitation and manipulation of others. Indeed, both clinical descriptions and empirical research have highlight that the deficits displayed by psychopaths do not pertain to comprehension of the lexical meaning of language, but involve a failure to assimilate the underlying affective nuances of semantic content (Blair et al., 2006; Hare, 1993). For example, non-psychopathic offenders exhibit faster reaction times in lexical decision tasks when presented with affectively-charged words (i.e., a priming effect), while offenders with psychopathic traits show no difference in reaction time between affectively-charged and neutral words (Lorenz & Newman, 2002; Williamson et al., 1991). When asked to rate words in affective and semantic priming tasks, individuals with psychopathy demonstrate significantly reduced affective priming and rate neutral words more positively when compared to non-psychopathic controls (Blair et al., 2006). However, no significant differences emerge between individuals with psychopathy and controls in semantic priming (Blair et al., 2006). Early on, Robert Hare (1993; Williamson, Harpur, & Hare, 1991) suggested that an inability to process subtle nuances relevant to the emotional dimension of language is core to the disorder. In a classic empirical demonstration of this phenomenon, Hare, Williamson, and Harpur (1988) instructed participants to group together words that were closely related in meaning from either affectively-charged or neutral word lists. Individuals with psychopathy demonstrated a tendency to group words based on lexical characteristics without consideration for affective connotation, while controls grouped words primarily based on affective dimensions (Hare, Williamson, & Harpur, 1988). Further supporting Hare’s claim is neurological research findings illustrating abnormal emotional processing of linguistic information. Specifically, using cortical electroencephalography (EEG) techniques, Kiehl, Hare, McDonald, and Brink (1999) found that individuals with psychopathy exhibited less activation in the amygdala and cingulate, areas of the brain relevant to emotion and attentional processes, when asked to memorize a list of more abstract compared to concrete emotionally-charged words.

Individuals with psychopathic traits also show difficulties in tasks of vocal affect recognition with regards to both prosodic and semantic cues in speech (Bagley, Abramowitz, & Kosson, 2009). With regards to comprehending emotionally relevant prosodic cues, individuals with psychopathy have demonstrated a reduced ability to recognize fearful affect in others' speech (Blair et al., 2002). Such failures to appropriately process emotional information presented through language has implications not only for the present-oriented cognitive style of individuals with psychopathy described in the literature (see Brinkley, Newman, Harpur, & Johnson, 1999), but also for the individual's capacity to perceive other's expressed emotions.

While the literature has consistently noted deficits in processing affectively-charged language, significant differences in the semantic content of both written and vocal communication surrounding affective experience in individuals with psychopathy have also been identified. Such language deficits may reflect generalized disturbance in psychopathic individuals ability to regulate and interpret emotion (Garofalo & Neumann, in press; Hoppenbrouwers et al., 2015). Persons with psychopathic traits often exhibit difficulties in storing and recalling emotional information (Dolan & Fullam, 2005), and often have difficulty describing the emotional context of their actions or focus on negative aspects of the situation (Dolan & Anderson, 2002). One interpretation of this set of findings, in combination of those found in schizophrenia research, is that language-related disturbances become evident for psychopathic individuals when affective arousal levels increase (i.e., situations requiring emotion regulation).

With regards to semantic content, psychopathic language is generally less emotionally intense and characterized by greater utilization of past tense verbs, suggestive of greater psychological distancing and emotional detachment (Hancock, Woodworth, & Porter, 2013). Past-orientation in speech is especially indicative of greater levels of emotional distancing, suggesting that offenders with psychopathy may be more emotionally detached from their previous criminal behavior than non-psychopathic offenders (Hancock et al., 2013). Furthermore, Hancock and colleagues (2013) found that, when asked to describe their crimes, speech produced by homicide offenders high in the psychopathy Interpersonal and Affective trait domains were characterized by less intense emotional words, as well as a greater proportion of negatively valenced words compared to non-psychopathic offenders. Additionally, speech output of offenders with pronounced psychopathic personality traits was more disfluent (e.g., “uh”, “um”) and past oriented (Hancock et al., 2013). The observed increases in disfluency in those high in interpersonal and affective characteristics of psychopathy is intriguing given that verbal disfluencies have been documented when there are multiple cognitive choices or demands (Schachter, Christenfeld, Ravina, & Bilous, 1991). Within the context of evidence supporting psychopathic deficits in processing emotionally charged content, specifically language, at the neurobiological level (see Bagley et al., 2009; Intrator et al., 1997; Kiehl et al., 1999; Williamson et al., 1991), the Hancock et al findings of increased disfluency of language suggests that communicating emotional context represents an area of increased cognitive demand in those with psychopathic traits.

While differences in content channels of communication surrounding affectively charged contexts in individuals with psychopathic personality have been documented using lexical analysis methods, there is little research on prosodic distinctions of psychopathic speech. This is surprising given that prosody involves emotional aspects of speech. Given noted impairments in psychopathic individuals' ability to recognize prosodic cues relevant to affective state (see Bagley, Abramowitz, & Kosson, 2009; Blair et al., 2002), prosodic channels of natural speech may provide an important avenue for conceptualizing affective disturbances in psychopathy. Neurobiological evidence has emerged indicating that the basal ganglia and amygdala play a role in prosodic expression in adults without brain injury (Van Lancker, Sidtis, Pachana, Cummings, & Sidtis, 2006). Importantly, consistent abnormalities in amygdala functioning have been noted in both adult (see Kiehl, 2006) and adolescents (Marsh et al., 2013) with psychopathic traits, such that psychopathic traits were associated with decreased amygdala activation to affectively charged stimuli. Prosodic analyses may be able to provide novel insight into the affective processes associated with psychopathic traits.

Current empirical evidence considering prosodic distinctions in psychopathic speech have primarily focused on "microscopic" aspects of natural speech. For example, de Almeida Brites et al (2015) found no differences between psychopathic and non-psychopathic offenders in terms of phonetic qualities and phonological processes, indicating that psychopathic offenders exhibit basic language competencies. While such "micro" level analyses offer data regarding physical motoric processes necessary for speech, they are unable to provide aggregate statistics of speech production necessary to indicate more stable phenomena (e.g., deficits in cognitive and affective processing) across samples available through analyses of "macroscopic" aspects of speech. A preliminary examination of "macroscopic" speech variables (e.g. variations in the amplitude and rate of speech) in an offender sample concluded that offenders with psychopathy not only spoke more quietly and slowly when describing emotional content, but also did not differentiate in terms of vocal emphasis between neutral and affectively charged words (Louth, Williamson, Alpert, Pouget, & Hare, 1998). However, the early technologies utilized by this study may have failed to recognize more nuanced prosodic differences in psychopathic speech, and suffered from a small sample size (*n* = 20). In a more recent study of nonverbal indicators of deception in an offender sample, psychopathy was associated with being more verbose, a faster rate of speech, and increases in speech hesitations and indicator use (Klaver, Lee, & Hart, 2007). However, no study to date has examined more nuanced prosodic differences in a large sample of psychopathic offenders with regards to affective expression utilizing recent sophisticated "macroscopic" acoustic analysis technologies, such as the CANS.

The Present Study

Semantic variables have demonstrated utility in highlighting a number of theoretically relevant constructs to psychopathy, particularly with regards to disturbances in both affective expression and comprehension of emotionally charged content. However, past research into psycholinguistic variables relative to psychopathy is limited in several key ways. First, prior research has not considered how psychopathic speech may vary as a function of contextual variables relevant to a given speech probe. Given that natural speech varies widely and is influenced by contextual and individual difference variables (e.g., affective context of the probe, arousal, cognitive differences; see Cohen, Dinzeo et al., 2015b), it is critical to consider how the context of the probe used to elicit speech may serve to influence the output across a series of probes within the individual. Second, prior research has neglected to provide a neutral, baseline sample of speech as a means of comparison, or consider the role of arousal evoked by speech probe. Paradigms used in previous studies utilize retrospective, affectively-based probes that evoke a high level of arousal in participants (e.g., prompting inmates convicted of homicide to recount the details of their offense; see Hancock, Woodworth, & Porter, 2013). While such paradigms effectively prime situations that should theoretically be associated with emotional responses, they neglect to consider baseline affective expression or the potential for variance in valence and arousal as a result of the probe. Finally, prior studies used relatively unsophisticated technologies and primarily examined variables relevant to amplitude and rate of speech. Furthermore, technological limits in prior research did not allow for a more nuanced examination of prosodic variables relevant to psychopathy, especially with a larger sample size. For example, Louth and colleagues (1998) examined variations in amplitude in a sample of only 10 psychopathic and 10 non-psychopathic offenders, which may have resulted in limited power to detect significant findings.

Given limitations in prior research into linguistic properties of psychopathic speech, the current study provides several methodological and theoretical advancements. The present study represents a novel effort in studying detailed prosodic variables of natural speech utilizing advanced acoustic analysis technologies. With regards to the classic observation of calloused and shallow affect in psychopathy (see Hare & Neumann, 2008), the utility of novel technologies to examine prosody could provide insight as to how “calloused” or “shallow” affective expression in psychopathic speech can be captured via macroscopic level speech variables, such as variability in intensity and fundamental frequency. Critically, usage of technologies focusing on “macro” level prosodic analysis represents a large methodological advantage in conceptualizing more stable phenomena in affective expression in psychopathic natural speech across multiple samples. Given the propensity for deception seen in individuals with psychopathy, an examination of prosodic variables may allow for a unique perspective regarding affective expression and experience. Furthermore, while prior research has studied the psycholinguistics of psychopathy using standardized laboratory probes, the present study provides a novel contribution by examining natural speech output in an offender sample in the context of a clinical interview (i.e. the PCL-R). Moreover, the present study examines variance in affect across segments of the interview designed to elicit both positively and negatively valenced emotional content, as well as neutral valence as a baseline and an exploratory "guilty" probe condition, across both high and low levels of subjective arousal.

Research Aims and Hypotheses

The purpose of the current study is to examine differences in "macroscopic" level prosodic variables (see Table 1) across a series of affectively charged probes of different valences and objective levels of arousal captured during a clinical interview with psychopathic (i.e. PCL-R total scores >30) and non-psychopathic (i.e. PCL-R total scores < 20) male offenders. Taken together, it is expected that psychopathic individuals, compared to non-psychopathic individuals, will show disturbances in prosodic speech when required to respond to affective-related probes. Based on previous literature and theory, the following hypotheses are offered.

Hypothesis 1. Offenders with psychopathy, compared to non-psychopathic offenders, will demonstrate differences in *speech production* variables (e.g., silence percent, pause frequency, mean pause length, utterance frequency, mean utterance length) when presented with affectively charged probes that elicit a high level of arousal.

Hypothesis 2. Offenders with psychopathy will demonstrate differences in *Fundamental Frequency* (F0; i.e., the lowest frequency originating from the vocal folds that represents the subjectively-defined pitch) variables compared to non-psychopathic offenders when presented with affectively charged probes that elicit a high level of arousal.

Hypothesis 3. Offenders with psychopathy will demonstrate differences in *First Format Frequency* (F1; i.e., vertical tongue articulation utilized for vowel expression) variables compared to non-psychopathic offenders when presented with affectively charged probes that elicit a high level of arousal.

Hypothesis 4. Offenders with psychopathy will demonstrate differences in *Second Format Frequency* (F2; i.e., horizontal and back-and-forth tongue articulation utilized for vowel expression) variables compared to non-psychopathic offenders when presented with affectively charged probes that elicit a high level of arousal.

Hypothesis 5. Offenders with psychopathy will demonstrate differences in *Intensity* (i.e., volume of speech) variables compared to non-psychopathic offenders when presented with affectively charged probes that elicit a high level of arousal.

5a. Consistent with previous literature (Louth et al., 1998), psychopaths' speech will show smaller range of variability in terms of intensity compared to non-psychopathic controls across affectively-charged contexts.

Given the exploratory nature of the proposed study, the following research question is proposed.

Research Question. Will psychopathic offenders demonstrate prosodic differences at both the local (i.e. within a specific utterance) and global (i.e. across utterances) level of variability in speech when presented with affectively charged probes, compared to non-psychopathic offenders?

CHAPTER 2

METHODS

Design

The present study utilized a 2 (Psychopathic, Non-psychopathic) X 2 (Positive, Negative Valence) X 2 (High, Low Arousal) quasi-experimental design, with psychopathy status (psychopathic, non-psychopathic) as a between-subjects factor, and valence and arousal serving as within-subjects factors. Although the proposed study included a neutral valenced probe condition, initial analyses indicated no significant differences between groups on measures of speech production or variability. As such, it was ultimately decided to exclude comparisons between the neutral probe and probes of different valence and arousal levels from analyses. Given that a standardized administration of the PCL-R interview was used, probes (i.e., interview questions) designed to theoretically evoke affectively-charged, retrospective memory were selected to serve as within-subjects conditions. Probes were selected based on their content relevant to the Affective Norms for English Words (ANEW; Bradley & Lang, 1999) dimensional norms for valence and arousal. Probes were selected that contained only one affectively-charged word, based on ANEW criteria. Interview valence (positive, negative) and interview arousal (high, low) elicited by the standardized probes from audio-recorded PCL-R interviews served as the within-subjects variables. An additional exploratory “guilty” probe was included in the present analysis, due to the theoretical importance of a lack of remorse or guilt to the construct of psychopathy (Hare & Neumann, 2008).

Psychopathy status was determined using PCL-R total scores to carry out an extreme group approach (EGA), such that individuals with PCL-R scores greater than or equal to 30 comprised the psychopathic group and those with PCL-R scores less than or equal to 20 comprised the non-psychopathic control group. Offenders with total PCL-R scores between 21 and 29 were omitted from the present study in an attempt to increase sensitivity of detecting psychopathy at the cost of decreasing specificity (i.e., failure to include potential psychopathic individuals; see Hervé, 2007; Mokros, Hare, Neumann, Santtila, Habermeyer, & Nitschke, 2015). Offenders in the psychopathic and non-psychopathic groups were matched on the basis of age, level of education, and IQ prior to analyses. The two groups were also comparable in terms of race/ethnicity. Participants whose length of time (in milliseconds) of the total recorded speech sample were two standard deviations from the mean were excluded from the analyses in each probe. The dependent variables were measures of prosody relevant to speech production (e.g., pause frequency and mean, utterance frequency and mean, silence percent) and variability (e.g., fundamental format frequency (F0); first format frequency (F1); second format frequency (F2); intensity) obtained from digitized samples of speech subjected to CANS protocol. See Table 1 for a complete list of dependent measures utilized in the present study generated from the CANS protocol.

Participants

The current study utilized data from the Southwest Advanced Neuroimaging Cohort (SWANC) study, an investigation of brain structure and function among criminal offenders. The sample drawn for the current study were based on a larger sample of 737 male adult offenders in the New Mexico Prison System. Inclusion criteria included offenders between 18 and 60 years of age, fluent in English with reading skills at 4th grade level or higher, IQ score of 70 or higher, and without a history of seizures, psychotic disorder (self or first degree relative), current alcohol or drug use, or traumatic brain injury (TBI). The present study investigated prosody in male offenders only, as the generalizability of psychopathy n females continues to be a fluid and open area of research (see Vitale et al., 2007). Psychopathy status was determined using PCL-R total scores through an extreme group approach (EGA), such that individuals with PCL-R scores greater than or equal to 30 comprised the psychopathic group and those with PCL-R scores less than or equal to 20 were assigned to the non-psychopathic control group.

The present study utilized a total of 93 participants from the larger SWANC sample, selected so that they were comparable in age, education, and IQ, with 49 participants in the psychopathic group and 44 participants in the non-psychopathic group. In the psychopathic group, the sample was predominately Hispanic/Latino (51%), with a smaller proportion identifying as non-Hispanic/Latino White (26.5%), Black or African American (12.2%), American Indian/Alaska Native (8.2%), and Asian (2%). In the non-psychopathic group, the sample was predominately Hispanic/Latino (47.7%) and non-Hispanic/Latino White (47.7%), with a smaller proportion identifying as American Indian/Alaska Native (4.5%). Descriptive statistics for demographic variables in psychopathic and non-psychopathic groups can be found in Table 2.

Measures

Computerized Analysis of Natural Speech (CANS)

The Computerized Analysis of Natural Speech (CANS; Cohen et al., 2009) is an automated protocol designed to assess vocal expressions from natural speech. Originally developed to bridge methodologies of both semantic and prosodic analyses, the CANS provides a more nuanced analysis of digitally recorded speech than previously available. The CANS procedure is performed in two distinct steps. First, recordings are analyzed using the Praat system (Boersma, 2001), a shareware program commonly used in speech pathology and linguistic analysis, that organizes sound files into “frames” for the purpose of analyses. A typical organization is approximately 100 frames per second. During each frame, prosodic variables are quantified for the purpose of later analysis. Following Praat analyses, the output is then analyzed using a series of macros to extract prosodic variables of interest for the purpose of analysis. Typical variables utilized in previous studies using CANS protocols (see Cohen et al., 2009; Cohen et al., 2014; Cohen et al., 2015; Cohen et al., 2016) concern aspects of speech production and variability. Prosodic variables examined in the current study can be found in Table 3.

Psychopathy Checklist – Revised (PCL-R)

The Psychopathy Checklist – Revised (PCL-R; Hare, 2003) is the most widely used measure of psychopathy in research, clinical, and forensic settings around the world (Neumann, Hare, & Johansson, 2013). The PCL-R assesses psychopathic traits using a 20-item clinician rated scale based on a semi-structured interview, extensive file review, and specific scoring criteria. Each item is rated as to the extent that it applies to an individual on a 3-point scale (0 = *the item does not apply*, 1 = *the item may apply or applies in some respects/conflicts between interview and file that cannot be resolved in favor of a 0 or 2*, or 2 = *the item applies to the individual; a reasonably good match in most essential respects*), with total scores ranging from 0 to 40 (Hare, 2003). A total PCL-R score of 30 or greater is typically used to diagnose psychopathy in both research and clinical settings (Hare, 2003). Recent evidence (Neumann et al., 2007) suggests that the PCL-R represents the construct as a superordinate psychopathy factor underpinned by four highly correlated, first-order factors (i.e. Interpersonal, Affective, Lifestyle, Antisocial), thus making it ideal for both higher-order person-centered analyses, as well as lower-order variable-centered analyses (Krstic et al., 2017). The current edition of the PCL-R (PCL-R, 2nd ed.; Hare, 2003) has demonstrated high reliability for both factor and total scores (Neumann et al., 2012). Additionally, the internal consistency of the second edition was excellent (α = .87) and the standard error of measurement was 3.0 for total scores (Hare, 2003).

Procedures

The present study utilized digital audio recordings of PCL-R interviews with psychopathic and non-psychopathic offenders from the New Mexico correctional system. Processing of offender audio samples occurred in two steps. First, trained research assistants (RAs) uploaded each audio-recorded PCL-R interview in its entirety to the WavePad audio editing software to begin the isolation and splicing process. RAs were instructed to listen to each PCL-R interview and identify segments of speech pertaining to standardized probes of interest posited to elicit affective responses of different valences and arousal levels. The probes of interest relevant to the present study, as well as the follow-up probe used to designate the end of the speech sample, can be found in Table 4.

In the isolation phase, segments of interest (i.e., standardized probes within the context of the PCL-R interview) were bookmarked and targeted for isolation upon identification, beginning with the initial utterance of the interviewer (i.e. when the interviewer begins speaking) and ending with the beginning of the subsequent probe, including the latency period between probe-irrelevant follow-up query and subsequent probe. After identification, RAs isolated the desired probe and saved it as a separate audio file labeled on the basis of the participant's identification number, as well as the valence and arousal level of the given probe (e.g., 1234_Positive_High; 1234_Negative_Low). RAs were instructed to maintain the integrity of the original audio sample, and saved the intact original interview as a separate file, labeled using the participant's identification number and phrase "whole" (e.g., 1234_WHOLE).

In the splicing phase, RAs removed any extraneous *interviewer utterances* (i.e., a segment of speech bounded by the other speaker that begins exactly when the other individual has stopped talking and ends exactly before the pause preceding the other speaker's utterance), *interviewer tokens* (i.e. short speech that does not count as an utterance, such as "uh-huh", "yeah", or "sure), and *background noise* (e.g., chairs clanging, loud noises in the hall over speech, voices over intercom) to ensure that only the subject's voice was in the final sample to be analyzed. After splicing out irrelevant speech and background noise, the completed audio files were saved in a password protected external hard-drive. Training protocols for audio isolation and splicing can be found in Appendix A. The samples were analyzed using the CANS protocol on-site at the University of North Texas (UNT).

Following audio processing, RAs were trained to criterion in determining valence and arousal levels of participant speech, as well as how content of speech samples related to valence and arousal ratings based on ANEW. To facilitate ease of interpretation, RAs utilized ANEW rating systems (e.g., rating valence and arousal on a scale of one to nine) to notate whether or not the participant's speech sample demonstrated the affective-charge theoretically posited by the probe condition. RAs were instructed to rate participant's speech as probe congruent, as indicated by the appropriate ANEW criteria, if the participant primarily adhered to the affective context elicited by the probe. If the participant speech contained indicators of numerous affective contexts, it was labeled as "mixed". Training protocols for valence and arousal coding can be found in Appendix B.

Data Preparation

A total of 737 offenders from the New Mexico prison were assessed on psychopathic personality traits using the Psychopathy Checklist-Revised (PCL-R) through the SWANC Study. A priori power analyses conducted in G*Power indicated that the current study would be sufficiently powered with 40 psychopathic and 40 non-psychopathic offenders to reach an effect size of 0.50. Of the 737 offenders in the SWANC dataset, only 65 obtained PCL-R scores greater than or equal to 30 to qualify for the psychopathic group. Three offenders who met criteria for the psychopathic group did not have audio-recorded samples of the PCL-R, and were thus deemed ineligible for the present study. An additional seven offender's audio files exhibited significant audio distortion, while six offenders' interviews did not adhere to the structure of the SWANC protocol and were deemed ineligible. A total of 49 offenders were selected to comprise the psychopathic group for the present study, and were utilized to identify matched cases on the basis of age, education, and IQ out of the 359 offenders who qualified for the non-psychopathic group. Race and ethnicity were not used for the purpose of matching due to limited cases which matched on all criteria, which would lead to insufficient power. Matched non-psychopathic cases were identified using the Fuzzy Extension for SPSS, which identified a total of 49 potential cases. Of the 54 cases identified for the non-psychopathic group, two were excluded as they did not have audio recorded PCL-R interviews and three were excluded on the basis of severe audio distortion and significant departures from the standardized PCL-R administration. As such, the final sample utilized for the present study was comprised of 49 psychopathic and 44 non-psychopathic offenders.

The first stage of data cleaning involved identifying participants who were missing a substantial amount of data (i.e., missing audio recorded segments for any of the probes of interest). Of the 93 cases which underwent the audio processing procedure, 78 cases had complete data, defined as possessing all five probes of interest as well as the experimental guilty probe. Fifteen cases were identified as having missing data. Of these cases, ten were missing only one probe (e.g., 4 cases were missing only guilty probe and 6 cases were only missing the positive valence, low arousal probe). Three cases were identified as missing two probes, and two cases were identified as missing four probes. Cases missing audio processing data for a specific probe were excluded from the analyses for that probe. A variable labeled "missing probe" identifying cases missing audio processing data for at least one probe was created, denoting cases with missing probe data as "1" and those with complete data as "0." Second, cases were identified with extreme response patterns in terms of recording length. Within each probe, cases with recording lengths less than 9,250 ms and those greater than 119,500 ms were excluded from analyses. Third, responses indicating extreme scores on speech variability and production variables were assessed. Examination of the data indicated significant departures from normality across several speech variables and probe conditions. However, examination of Mahalanobis distance indices indicated that the present study was within normal limits with regards to multivariate normality. Given the exploratory nature of the present study and lack of empirical evidence suggesting acceptability of transforming behavioral speech data, transformation of speech variables to achieve normality was not conducted.

Finally, meaningful differences between participants with and without missing audio data on probe conditions were assessed. A series of ANOVAs were conducted comparing age, level of education, IQ, and speech variability and production variables between participants with and without missing audio data on probe conditions. ANOVAs revealed that there were no significant differences between cases with and without missing audio data, indicating that the data were missing at random. Therefore, all cases with missing data in one probe, but available data for the probes of interest in analyses were included in each subsequent analysis.

Data Analysis

A priori power analyses conducted in G*Power indicated that the current study would be sufficiently powered with 49 psychopathic and 44 non-psychopathic offenders reaching an effect size of 0.50. Participants in the psychopathic and non-psychopathic groups were matched on the basis of age, level of education, and IQ prior to analysis. Chi-square analyses were utilized to examine significant differences between psychopathic and non-psychopathic groups on the basis of race and ethnicity. Results revealed that psychopathic offenders did not significantly differ on the basis of race, χ^2 (3, n = 93) = .10, p = .07, or ethnicity, χ^2 (1, n = 93) = 7.62, p = .75. Frequency and percentages were recorded for participants' race and ethnicity. Means and standard deviations were reported for age (in years), total scores for psychopathy (PCL-R), PCL-R facet scores, education level (in years), and IQ (see Table 2), as well as the dependent variables (speech production and speech variability prosodic variables collected by the CANS; see ANOVA Tables 6 through 11).

Analyses were carried out in IBM SPSS statistics version 23 (2015) in five steps. For the purpose of the current study, cases with recording lengths more than two standard deviations from the mean were excluded from analyses. First, separate correlation analyses were conducted in the psychopathic and non-psychopathic control groups to examine similarities and discrepancies in associations between PCL-R variables both at the facet (i.e., Interpersonal, Affective, Lifestyle, and Antisocial) and total score levels with the speech variability and production variables. Given the highly exploratory nature of the present study, multiple comparison analyses were not conducted. Second, analysis of variance (ANOVA) was conducted as an exploratory analysis in order to evaluate significant group differences across affectively charged contexts. Third, mixed effects multivariate analysis of variance (MANOVA) was conducted to test the main study hypotheses evaluating both group differences in speech production and variability (i.e. psychopathic vs. non-psychopathic groups), as well as determining variability in prosody across affectively-charged context (i.e. positive and negative valence; high and low arousal). Given the lack of significant group differences in the neutral probe condition at the univariate level, it was ultimately excluded from the final analysis. Fourth, for breakdown of significant interactions, paired-samples t-tests or standard t-tests were conducted within relevant levels of the factor not involved in the interaction to uncover the significant interaction effects in the within-subjects by group factors. Finally, correlation analyses were conducted to gauge the association of PCL-R facet and total scores to the speech production and variability variables, though these should be interpreted with caution given the use of an extreme groups design.

CHAPTER 3

RESULTS

Coded Valence and Arousal Ratings of Speech Samples

Mean valence and arousal ratings, as well as inter-rater reliability, for coded valence and arousal ratings across each probe condition (i.e., neutral, pos_high, neg_high, pos_low, neg_low, guilty) can be found in Table 5. Overall, the present sample demonstrated good to excellent inter-rater reliability across probe type, providing support for the methodology utilized by the current study. Furthermore, results indicated that participant speech was largely consistent with valence and arousal context elicited by the probes of interest.

Analysis of Variance (ANOVA) in Psychopathic and Non-Psychopathic Groups

For descriptive and exploratory purposes, a series of one-way analyses of variance (ANOVAs) were conducted across probes to examine significant group differences in speech variability and production outcome measures. Significant ANOVA results within each probe of interest are described below. See Tables 6 through 11 for results of ANOVA analyses.

Neutral Probe

Given that neutral probes were not part of the planned mixed MANOVAs, one-way ANOVAs were conducted to evaluate significant group differences in speech variability and production variables for the neutral probe. Variance in intensity mean ($F(1, 71) = 3.42$, $p = .07$), F2 slope mean ($F(1, 71) = 2.84$, $p = .09$), F1 mean ($F(1, 71) = 3.00$, $p = .09$), and F0 slope mean ($F(1, 71) = 3.37$, $p = .07$) were approaching significance, though none of these analyses reached conventional levels of significance. See Table 6 for neutral probe results.

Positive Valence, High Arousal Probe

A one-way ANOVA was conducted to evaluate significant group differences in speech variability and production variables in the positive valence, high arousal probe. Average pause length varied significantly across psychopathic and non-psychopathic groups, $F(1, 84) = 4.13$, $p = .04$, $\eta^2 = .05$. The psychopathic group ($M = 7{,}764.39$, $SD = 5{,}925.75$) had significantly shorter mean pause lengths than offenders in the non-psychopathic group ($M = 12{,}189.88$, $SD = 13{,}102.27$). Furthermore, average F2 slope varied significantly across psychopathic and non-psychopathic groups, $F(1, 84) = 4.72$, $p = .03$, $\eta^2 = .05$. Offenders in the psychopathic group ($M = 1.63$, $SD = 4.05$) had significantly larger average F2 slope scores than non-psychopathic offenders ($M = -0.67$, $SD = 5.68$). Group differences in F1 mean scores approached significance, $F(1, 84) = 2.89$, $p = .09$. See Table 7 for ANOVA results in the pos_high probe.

Negative Valence, High Arousal Probe

One-way ANOVAs were conducted to evaluate significant group differences in speech variability and production variables in the negative valence, high arousal probe. Average first format frequency (F1) varied significantly across psychopathic and non-psychopathic offenders $F(1, 64) = 5.51$, $p = .02$, $\eta^2 = .08$. Analyses revealed that offenders in the psychopathic group ($M = 108.91$, $SD = 3.33$) has significantly larger average F1 scores than non-psychopathic offenders ($M = 107.27$, $SD = 2.20$). Average intensity varied significantly across psychopathic and non-psychopathic offenders, $F(1, 64) = 3.96$, $p = .05$, $\eta^2 = .06$, with offenders in the psychopathic group ($M = 5.47$, $SD = 4.23$) displaying lower average intensity than non-psychopathic offenders ($M = 8.09$, $SD = 6.33$). Group differences in average second format frequency (F2) scores (F(1,

64) = 3.35, *p* = .07) approached significance. See Table 8 for ANOVA results in the neg_high probe.

Positive Valence, Low Arousal Probe

One-way ANOVAs were conducted to evaluate significant group differences in speech variability and production variables in the positive valence, low arousal probe. Utterance frequency varied significantly across psychopathic and non-psychopathic offenders, $F(1, 62) = 4.21$, $p = .04$, $h^2 = .07$. Offenders in the psychopathic group (*M* = 18.50, *SD* = 15.92) has significantly more utterances than non-psychopathic offenders (*M* = 11.67, *SD* = 10.12). Frequency of 5,000 millisecond (ms) pauses varied significantly across psychopathic and non-psychopathic offenders $F(1, 62) = 6.24$, $p = .02$, $h^2 = .09$, with offenders in the psychopathic group (*M* = 0.23, *SD* = 0.43) displaying more 5,000 ms pauses than non-psychopathic offenders (*M* = 0.03, *SD* = 0.08). Average first format frequency (F1) varied significantly across psychopathic and non-psychopathic offenders $F(1, 62) = 5.25$, $p = .03$, $h^2 = .08$. Analyses revealed that offenders in the psychopathic group (*M* = 109.35, *SD* = 3.13) has significantly larger average F1 scores than non-psychopathic offenders (*M* = 107.79, *SD* = 2.14). The global standard deviation of F1 scores varied significantly across psychopathic and non-psychopathic offenders $F(1, 62) = 4.32$, $p = .04$, $h^2 = .07$, with offenders in the psychopathic group (*M* = 2.35, *SD* = 1.35) displaying greater variability in the global standard deviation of F1 scores than non-psychopathic offenders (*M* = 1.68, *SD* = 1.14). Average second format frequency (F2) varied significantly across psychopathic and non-psychopathic offenders $F(1, 62) = 7.40$, $p = .01$, $h^2 = .11$. Offenders in the psychopathic group (*M* = 128.74, *SD* = 1.71) has significantly larger average F2 scores than non-psychopathic offenders (*M* = 127.66, *SD* = 1.44). Group differences in the length of recording (*F*(1, 62) = 3.58, *p* = .06), longest pause length (*F*(1, 62) = 3.63, *p* = .06), and intensity slope standard deviation (*F*(1, 62) = 3.13, *p* = .08) approached significance. See Table 9 for ANOVA results in the pos_low probe.

Negative Valence, Low Arousal Probe

One-way ANOVAs were conducted to evaluate significant group differences in speech variability and production variables in the negative valence, low arousal probe. No significant differences were found. See Table 10 for ANOVA results in the neg_low probe.

Guilty Probe

One-way ANOVAs were conducted to evaluate significant group differences in speech variability and production variables in the guilty probe. Average second format frequency (F2) varied significantly across psychopathic and non-psychopathic offenders *F*(1, 69) = 6.69, *p* = .01, h^2 = .09. Analyses revealed that offenders in the psychopathic group (*M* = 128.69, *SD* = 1.95) had significantly larger average F2 scores than non-psychopathic offenders (*M* = 127.54, *SD* = 1.78). Group differences in the first format frequency (F1) mean (*F*(1, 69) = 3.12, *p* = .07) and F1 local standard deviation (*F*(1, 69) = 3.55, *p* = .06) approached significance. See Table 11 for ANOVA results in the guilty probe.

Summary of the One-Way ANOVAs

Overall, it appeared that the psychopathic offenders displayed greater variation in average rate of change in F2 across the speech sample, larger average F1 and F2 values, greater average variation in F1 across utterances, higher frequency of utterances, higher frequency of 5,000 ms pauses, less intense speech, and shorter average pause lengths, compared to non-psychopathic offenders.

Bivariate Correlations

Bivariate correlations were conducted both within (see Tables 6 through 10 with ANOVA results) and across the psychopathic and non-psychopathic groups (see Tables 12 through 16) due to the current study's use of an extreme groups approach. Correlations between the four facets (e.g., interpersonal, affective, lifestyle, and antisocial) and PCL-R Total Score were examined across dependent variables generated from the CANS (e.g., speech production, fundamental frequency (F0), first format frequency (F1), second format frequency (F2), and intensity). Bivariate correlations for the psychopathic and non-psychopathic groups can be found in Tables 12 through 16. The correlational results within each group were used to aid in interpretation of MANOVA results. Overall, the pattern of results suggested that psychopathic traits were differentially correlated with the speech variables as a function of psychopathy status.

Mixed Effect MANOVA

Three factor mixed MANOVAs (2 Group x 2 Valence x 2 Arousal) were conducted to evaluate differences in speech production and variability measures generated by the CANS between psychopathic and non-psychopathic offenders within probes which differed on the basis of valence (i.e., positive, negative) and arousal (i.e., high, low). Commensurate sets of the 28 dependent variables were used to represent the valence (2-levels) and arousal (2-levels) within-subjects factors, using four speech variables at a time for each MANOVA. Results for all MANOVAs can be found in Table 17. No significant main effects were found on the basis of group (i.e., psychopathic or non-psychopathic). However, significant main effects were found for valence and arousal, which are shown in Table 17. No significant three-way interactions were found (e.g., Group x Valence x Arousal). As expected, there was some evidence of Group x Arousal interactions, and also, there were a number of significant group x valence interactions.

Significant multivariate effects were found on the basis of Group by Valence and Valence by Arousal, and effects approaching significance on the basis of group by arousal. Significant interactions on the basis of Valence by Arousal can be found in Table 17. In general, these interactions provided support for the study methodology, denoting various parts of the PCL-R interview in terms of valence and arousal.

Silence Percent

Percentage of silence in the speech samples demonstrated a significant group x valence interaction (F (1, 79) = 6.65; p = .01; Partial η^2 = .08). For interaction breakdown analyses, results of paired t-tests indicated that in high arousal conditions, non-psychopathic offenders demonstrated significantly greater percentages of silence in the negatively, compared to positively, valenced condition (t (38) = -7.48; p < .001). In the low arousal condition, non-psychopathic offenders also demonstrated significantly greater percentages of silence in the negatively, compared to positively, valenced condition (t (38) = -4.95; p < .001). Similarly, results of paired *t*-tests indicated that in high and low arousal conditions, respectively, psychopathic offenders demonstrated significantly greater percentages of silence in the negatively, compared to positively, valenced condition (t (40) = -4.78; p < .001), (t (40) = -2.50; p < .05). To further breakdown this interaction, a *t*-test was conducted to determine how the groups differed in negative valence (aggregated across arousal level). The *t*-test results indicated that the non-psychopaths (*M* = 32.90, *SD* = 13.80) displayed greater silence percentage in the negative probe, compared to the psychopaths (*M* = 27.26, *SD* = 14.02), $t(88) = 1.916$, $p = .059$, though this fell just short of conventional levels of significance. Graphical depictions of significant interactions in silence percentage on the basis of group and valence can be found in Figures 1 through 3.

Longest Pause

A group by valence interaction was found for pause length, (F (1, 78) = 4.88; $p = .03$; partial $\eta^2 = .06$). For interaction breakdown analyses, results of paired-samples *t*-tests indicated that in high arousal conditions, non-psychopathic offenders demonstrated significantly larger longest pause lengths in the positively, compared to negatively, valenced condition (t (38) = 8.32; $p < .001$). In the low arousal condition, non-psychopathic offenders also demonstrated significantly larger longest pause lengths in the positively valenced condition (t (38) = 4.38; $p < .001$). Similarly, results of paired-samples *t*-tests indicated that in high and low arousal conditions, respectively, psychopathic offenders demonstrated significantly larger longest pause length in the positively valenced condition (t (40) = 4.41; $p < .001$), (t (40) = 2.46; $p < .05$). To further breakdown this interaction, a *t*-test was conducted to determine how the groups differed in positive valence, aggregated across arousal level. The *t*-test results indicated that non-psychopathic offenders (*M* = 94512.56, *SD* = 11997.42) displayed longer pauses in the positive probe, compared to psychopathic offenders (*M* = 86511.71, *SD* = 19817.38), t (78) = 2.17, $p = .03$. Graphical depictions of significant interactions in longest pause length on the basis of group and valence can be found in Figures 4 through 6.

Pause Mean

For average pause length, a group by valence interaction was uncovered (F (1, 78) = 3.56; p = .06; partial η^2 = .04). Results of paired-samples t-tests indicated that in high arousal conditions, non-psychopathic offenders demonstrated significantly larger average pause lengths in the positively, compared to negatively, valenced condition (t (38) = 4.12; p < .001). In the low arousal condition, non-psychopathic offenders also demonstrated significantly larger average pause lengths in the positively, compared to negatively, valenced condition (t (38) = 3.49; p < .001). Results of paired-samples t-tests did not indicate significant differences in average pause length on the basis of valence in either high or low arousal conditions in psychopathic offenders. Graphical depictions of significant interactions in average pause length on the basis of group and valence can be found in Figures 7 through 8.

Average Variation within Utterance Fundamental Frequency (F0 SD Local)

There was a group by valence interaction for F0 SD local (F (1, 70) = 6.58; p = .01; partial η^2 = .09). Results of paired-samples t-tests indicated that in high arousal conditions, non-psychopathic offenders demonstrated significantly greater values in F0 SD local in the positively valenced condition (t (36) = 2.45; p < .05). In the low arousal condition, non-psychopathic offenders did not demonstrate any significant differences on the basis of valence. Results of paired-samples t-tests did not indicate significant differences in F0 SD local values on the basis of valence in either high or low arousal conditions in psychopathic offenders. Graphical depictions of significant interactions in F0 SD Local on the basis of group and valence can be found in Figures 9 through 10.

Average Variation within Utterance First Format Frequency (F1 SD Local)

There was a trend for a group by arousal interaction for F1 SD local, (F (1, 70) = 2.90; p = .09; partial η^2 = .04). Given the exploratory nature of the current study, further investigation of the interaction was conducted to evaluate potential differences on the basis of arousal between psychopathic and non-psychopathic offenders. Results of paired-samples t-tests did not indicate significant differences in F1 SD local values on the basis of arousal in either positively or negatively valenced conditions in non-psychopathic offenders. In contrast, results of paired-samples t-tests indicated that in positively valenced conditions psychopathic offenders demonstrated significantly greater F1 SD Local values in the low, compared to high, arousal condition (t (40) = -4.78; $p < .001$). In the negatively valenced condition, psychopathic offenders did not demonstrate any significant differences in F1 SD local on the basis of arousal level. Graphical depictions of significant interactions in F1 SD local on the basis of group and arousal can be found in Figures 11 through 12.

Average Variation within Utterance Second Format Frequency (F2 SD Local)

For the F2 SD local variable there was a group by valence interaction (F (1, 70) = 5.40; p = .02; partial η^2 = .07). Results of paired-samples t-tests indicated that in low arousal conditions, non-psychopathic offenders demonstrated significantly greater values in F2 SD local in the positively, compared to negatively, valenced condition (t (36) = 2.54; $p < .05$). In the high arousal condition, non-psychopathic offenders did not demonstrate any significant differences in F2 SD local on the basis of valence. Results of paired-samples t-tests did not indicate significant differences in F2 SD local values on the basis of valence in either high or low arousal conditions in psychopathic offenders. Graphical depictions of significant interactions in F2 SD local on the basis of group and valence can be found in Figures 13 through 14.

F2 Slope Mean

Average rate of change across the speech sample in second format frequency (i.e., F2 slope mean) demonstrated a trending group by arousal interaction, (F (1, 70) = 3.28; p = .08; partial η^2 = .04). Given the exploratory nature of the current study, further investigation was conducted to evaluate potential differences on the basis of arousal between psychopathic and non-psychopathic offenders. Results of paired-samples *t*-tests did not indicate significant differences in F2 slope mean values on the basis of arousal in either positively or negatively valenced conditions in non-psychopathic offenders. Results of paired-samples *t*-tests indicated that in positively valenced conditions, psychopathic offenders demonstrated significantly greater F2 slope mean values in the high, compared to low, arousal condition (t (34) = 2.01; $p < .05$). In the negatively valenced condition, psychopathic offenders did not demonstrate any significant differences in F2 slope mean on the basis of arousal. Graphical depictions of significant interactions in F2 slope mean on the basis of group and arousal can be found in Figures 15 through 16.

CHAPTER 4

DISCUSSION

Psychopathy is a pathological condition that has enormous costs for society at large, as well as for those who encounter psychopathic individuals (Kiehl & Hoffman, 2011). In particular, psychopathy is one of the most important predictors of violence and criminal recidivism (Olver, Neumann et al., in press). As such, reliable and valid assessments for identifying psychopathic individuals has been a major research effort (Hare & Neumann, 2008). While the PCL-R and related instruments are indispensable for assessment of psychopathy, it would be a significant advancement for the field if additional methods can be developed to augment current assessment strategies. The present study aimed to examine differences in "macroscopic" level prosodic natural speech variables across a series of affectively charged probes of different valence and arousal levels in the context of a clinical interview in psychopathic (i.e. PCL-R total scores >30) and non-psychopathic (i.e. PCL-R total scores < 20) male offenders. As anticipated, the MANOVA analyses revealed significant interactions suggesting that psychopathic and non-psychopathic offenders differed in their prosodic speech as a function of arousal level, as well as affective valence. In addition, the results indicating significant main and interaction effects of valence and arousal providing support for the methodology utilized by the present study.

When examining variance in speech in probes of different valence and arousal levels, results indicated that both psychopathic and non-psychopathic offenders demonstrate greater percentages of silence in negatively valenced probes across high and low arousal levels. However, compared to non-psychopathic offenders, psychopathic offenders evidenced a smaller percentage of silence in negatively valenced conditions across arousal level. Interestingly, examination of bivariate correlations indicated that higher PCL-R total scores were associated with a lower overall silence percent, though only in non-psychopathic offenders. No significant bivariate correlations emerged between silence percent and PCL-R facets or total score in other negatively valenced probes conditions across groups. Taken together these findings indicate that generating negatively-valenced content from one's autobiographical history may represent an area of increased cognitive load in non-psychopathic offenders, in line with findings indicating that increased silence percentage may be associated with the impact of cognitive load (Cohen et al., 2015). However, it would appear that, for psychopathic offenders, negatively valenced content had less of an impact in terms of percentage of silence, which may have been due to the fact that cognitive load of psychopathic offenders was not impacted by probes regarding negatively valenced content.

The results also revealed that psychopathic and non-psychopathic offenders demonstrated significantly larger pause lengths for positively compared to negatively valenced probes across arousal levels, though further breakdown analyses indicated that non-psychopaths displayed longer pauses than did psychopaths. As such, these results may also reflect the impact of increased cognitive load, relative to the psychopaths, upon recall of positively valenced information for non-psychopathic offenders. Moreover, the results appear to suggest that the affective valence of the PCL-R interview had less of an impact on the psychopathic offenders, compared to the non-psychopaths. Such a finding is consistent with brain imaging research that suggests psychopathic traits are inversely associated with lower gray matter volume in the entire limbic system, which is fundamentally involved in affective experience (Baskin-Sommers, Neumann, et al., 2016). Taken together, it may be that dysfunction of the limbic system translates to relative insensitivity to affective context and speech related processes.

Somewhat in contrast to the findings of Louth et al (1998) and Klaver et al (2007), the results indicated that psychopathic offenders also evidenced fewer hesitations (longest pause) within the context of positively valenced probes. These results provide further support for the importance of examining variation in prosodic variables across affectively charged conditions, as differences between psychopathic and non-psychopathic offenders may emerge only within certain valenced contexts. These findings may suggest that psychopathic offenders evidence greater fluidity in speech when discussing accomplishments could reflect greater confidence and persuasive ability. Relatedly, in the positive valence, high arousal condition, higher mean scores on the Interpersonal trait domain were associated with shorter longest pause lengths, in non-psychopathic offenders.

In high arousal conditions, average variation at the within-utterance level in fundamental frequency (F0; i.e., lowest frequency originating from vocal folds that defines subjective pitch) was greater in the positively compared to negatively valenced condition in non-psychopathic offenders. However, results indicated that psychopathic offenders's variability in F0 at the within utterance level were not significantly impacted by valence across arousal conditions. As before, these findings suggest that psychopathic offenders may be relatively unaffected by valence context in terms of variance in subjectively-defined pitch at the within-utterance level. Interestingly, examination of the bivariate correlation results in the positive valence, *high arousal* probe, condition indicated that for psychopathic offenders, higher mean scores on the Affective trait domain (callousness, lack of remorse) were associated with greater within-utterance variation in F0. These findings may reflect difficulty associated with generating strongly felt, positive affect, leading to greater attempts at regulating speech output by offenders with psychopathy. Furthermore, bivariate correlations in the negative valence, *low arousal* conditions indicated that higher mean scores on the Affective and Antisocial trait domains and lower mean scores on the Interpersonal trait domain were associated with greater within-utterance variation in F0 in psychopathic offenders. Taken together, the pattern of correlations of the PCL-R trait domains appear to be differentially associated with variation of F0 (subjective pitch), across arousal contexts, and may be an important avenue to pursue in further research.

Non-psychopathic offenders also demonstrated significantly greater variation at the within utterance level in second format frequency (F2; i.e., horizontal tongue articulation used for vowel expression) in positive valence in the context of low arousal conditions. Results did not support any effect of valence on within-utterance variation in vowel articulation in psychopathic offenders across arousal conditions. These findings again provide support for the notion that psychopathic offenders are relatively unaffected by the impact of affective valence in terms of articulation at the within-utterance level. At the same time, in the positive valence, *low arousal* probe condition, higher mean scores on the Lifestyle trait domain and lower mean scores in the Affective trait domain were associated with greater within-utterance variation in F2 in the psychopathic offender group. These findings are intriguing in light of recent research that found increased Lifestyle and decreased Affective traits were associated with increased behavioral activation system drive (i.e., reward seeking; Hoppenbrouwers, Neumann, Johansson, 2015). As such, the current pattern of findings related to within-utterance variation in F2 may reflect efforts at regulating speech output through articulation when discussing various accomplishments, or perhaps an increase in motivated behavior.

Across high and low arousal conditions, non-psychopathic offenders demonstrated longer average pause lengths in positively valenced probes, while psychopathic offenders were not impacted by valence across arousal levels in terms of average pause length. Results of bivariate correlations did not show significant associations at the trait domain level in the positive valence, low arousal condition in psychopathic or non-psychopathic offenders. However, in non-psychopathic offenders, higher mean scores on the interpersonal trait domain were associated with shorter average pause lengths in the positive valence, high arousal condition. Contrary to expectations, these findings suggest that psychopathic offenders were relatively unaffected by valence in terms of speech production, providing evidence of greater fluidity of speech relative to non-psychopathic offenders. Notably, in the negative valence, *high arousal* condition, higher mean scores on the Antisocial facet were associated with shorter average pause lengths in psychopathic offenders. Taken together, these results may indicate that offenders with psychopathy are more fluid in terms of speech than non-psychopathic offenders under high arousal conditions when probed about positively-valenced content, instead of showing greater disruption in speech production.

While the valence context of the PCL-R interviews did not influence the prosodic speech of the psychopathic offenders as much as it did for the non-psychopathic offenders, the results suggested that arousal context of the interview did influence psychopathic speech. When examining average variation at the within-utterance level in first format frequency (F1; i.e., vertical tongue articulation used in vowel articulation), results indicated that while non-psychopathic offenders did not differ significantly on the basis of arousal across valence conditions, effects for psychopathic offenders did emerge. Psychopathic offenders demonstrated greater within-utterance variation in F1 in low arousal probes in the context of positively valenced conditions. These findings provide initial evidence that although psychopathic speech may be relatively unaffected by valence, it is still subject to the effects of arousal in terms of articulation.

Furthermore, results of one-way ANOVA indicated that psychopathic offenders also demonstrated greater variation across-utterances in F1 and larger average F1 scores in the context of the positively valenced, *low arousal* probe condition. In the context of negatively valenced, *high arousal* probe conditions, psychopathic offenders also demonstrated larger average F1 scores, but lower average intensity values. These findings indicate that when discussing aspects of their autobiographical history associated with negative affectively charged content that elicits a high level of arousal, psychopathic offenders on average speak at a lower level of volume and with greater vowel articulation. Speculatively, this might be an example of changing voice to adjust for affective experiences (and perhaps trying to change affect expression), as well as an absence of speech variation, when presented with high arousal contextual questioning.

Although non-psychopathic offenders did not evidence significant differences in average rate of change across the speech sample in F2 on the basis of arousal across valenced conditions, psychopathic offenders demonstrated greater average rates of change in F2 in the high arousal probe within the context of positively valenced condition. Further examination of bivariate correlations indicated that in psychopathic offenders, higher mean scores on the Interpersonal trait domain were associated with less average rate of change in F2 in the positive valence, low arousal condition. The relationship between psychopathic traits and greater average rates of change in F2 values additionally emerged within the context of one-way ANOVA is the positive valence, high arousal conditions. Furthermore, one-way ANOVA indicated that psychopathic offenders showed overall larger average F2 values than non-psychopathic offenders in the positively valenced, low arousal condition. Contrary to findings in a systematic review conducted by de Almeida-Brites (2016) indicated no difference in basic articulation variables between psychopathic and non-psychopathic offenders, psychopathic offenders in the present study demonstrated greater change in vowel articulation, which may represent greater efforts at affective regulation when probed about positively valenced, high arousal content.

Taken together, these findings suggest that psychopathic offenders may be largely unaffected by the impact of valence in terms of production and variability of natural speech. In valenced contexts, offenders with psychopathic traits demonstrated greater fluidity in terms of speech production (e.g., less percent of silence, shorter longest pause lengths, no significant differences on average pause length) and less variability at the within utterance level (e.g., F0 SD Local, F2 SD Local) when compared to non-psychopathic offenders. Findings concerning greater fluidity of speech within psychopathic offenders may be interpreted as reflecting functions of speech potentially adaptive for manipulation and deceit, as evidenced by relationships which emerged between speech production variables and the Interpersonal facet domain in bivariate correlations. When considering valence, it would appear that psychopathic offenders are less variable at the within utterance level in terms of subjectively-defined pitch and vowel articulation, providing some evidence of the classic observation of flattened affectivity in psychopathy (Cleckley, 1941; 1976; Hare & Neumann, 2008). However, trending group by arousal interactions provide some support for the notion that while psychopaths are relatively unaffected by valence in terms of variability, they demonstrated both greater variability at the within utterance level and greater rates of change across utterances in articulation on the basis of arousal relative to non-psychopathic offenders. As such, the present study provides initial evidence contradicting flattened affective expression in psychopathy when examining natural speech using objective, computerized assessments. These findings have important clinical implications suggesting the potential utility of adjunctive computerized assessments of affective expression such as the CANS in assessing affective expression in psychopathy, given the low discriminatory power observed in the blunted affective expression item on the PCL-R (Neumann & Hare, 2008).

The present study, while a first attempt at a challenge topic, not to mention a data heavy enterprise, nonetheless should be taken within the context of several limitations. Notably, participants missing data in probe conditions, as well as those who generated speech samples that were not of a sufficient length to produce aggregate variability statistics, contributed to the study being under-powered to find significant effects. The present study's use of an extreme groups approach (EGA) to determine psychopathy status further contributed to a lack of power to detect significant effects, particularly in bivariate correlation analyses. Additionally, empirical evidence indicates that psychopathic traits may be better represented as a dimensional rather than taxometric construct (Edens, Marcus, Lilienfeld, & Poythress, 2006; Wright, 2009). As such, the present study's use of an extreme groups approach to determine psychopathy status may have limited the variation of expression of natural speech across a construct that is better represented dimensionally. Future research should examine variation in natural speech utilizing a dimensional approach to conceptualizing psychopathic traits in order to better understand variance across the psychopathy spectrum in an offender sample. Furthermore, many of the indices of speech production and variability violated assumptions of normality and homogeneity of variance necessary to conduct comparison of mean values between psychopathic and non-psychopathic groups. Given the exploratory nature of the present study and the use of behavioral data, it was decided to forgo transformation of non-normal speech indices in order to aid interpretation of findings (Osborne, 2002). Furthermore, extreme cases (i.e., greater than two standard deviations above or below the mean) were excluded from analyses in order to better approximate univariate normality and examination of Mahalanobis distance indices suggested that assumptions of multivariate normality were not violated. Additionally, an examination of non-parametric tests (e.g., Wilcoxon signed-rank test) revealed similar pattern of results between parametric and non-parametric analyses with regards to significant group differences. Finally, the present study did not adjust conventional levels of significance given the large number of statistical analyses conducted. As such, it is possible that significant findings may be due to chance. However, the pattern of findings of the present study were both consistent with theory and previous research, which provides some support of their validity.

Although the present study had several limitations, it also had several notable strengths, namely, its use of an offender sample and natural speech data collected from the context of a clinical interview. Although analyses were unable to be conducted with regards to the neutral probe, the present study's use of probes of differential valence and arousal levels allowed for examinations in variance in speech as a function of emotional context of the probe. Overall, the findings highlight differences in prosody across affectively-charged contexts, across different arousal levels, among psychopathic offenders. In future research, it may be advantageous to link the speech variables to aspects of neurobiology and criminal recidivism.

Table 1

Descriptions of Macro-level Properties of Speech (see Cohen et al., 2009; Cohen et al., 2010; Cohen et al., 2016)

Variable	Description
	Fundamental Vocal Expression
Fundamental Frequency (F0)	The lowest frequency originating from the vocal folds that defines the subjectively-defined pitch
First Format Frequency (F1)	Vertical tongue articulation important for vowel expression
Second Format Frequency (F2)	Horizontal and back-and-forth tongue articulatulation also used for vowel expression
Intensity	Volume
Utterance mean	Average utterance length in ms
Pause mean	Average pause length in milliseconds (ms)
	Variability of the Signal
Inflection	Variability in pitch – both within utterance (i.e. locally) and across utterances (i.e. globally)
Frequency Perturbation	Absolute value of average change in consecutively voiced frames within utterance, averaged across utterances
Amplitude	The mean volume
Intensity Perturbation	Absolute value of average change in consecutively voiced frames within utterance, averaged across utterances
Local Emphasis	S.D. of intensity values computed within each utterance and averaged across all utterances
Local Intonation	S.D. of F0 values computed within each utterance and averaged across all utterances
	Frequency of Distinct Events
Silence percent	Percent of time not speaking
Pause frequency	Total number of pauses [> 150 ms]
Utterance frequency	Total number of utterances (> 150 ms)

Table 2

Descriptive Statistics for Psychopathic and Non-Psychopathic Groups

Variable	Non-Psychopathic Group		Psychopathic Group	
	M	SD	M	SD
Age	33.89	8.67	33.47	8.68
IQ	99.39	14.32	101.14	14.63
Education	9.97	3.35	10.41	3.98
PCL-R Total	17.86	2.52	31.87	2.00
Interpersonal Mean	0.27	0.27	1.33	0.43
Affective Mean	0.67	0.33	1.54	0.31
Lifestyle Mean	1.02	0.29	1.62	0.22
Antisocial Mean	1.46	0.33	1.78	0.24

Table 3

Computerized Acoustic Analysis Variables Examined in the Current Study

Variable	Description	Increasing scores reflect	Units of Measure
	Speech Production		
Recording Length	Length of the total speech sample in milliseconds (ms)	Longer speech samples	Milliseconds
Latency to 1st Utterance	Length of silence, in ms, prior to initial utterance	Longer time to begin speech	Milliseconds
Silence percent	Percent of time not speaking	Less % of time not speaking	Percentage
Pause frequency	Total number of 500, 1000, and 5000 ms pauses	More pauses	# of pauses per 2 min. of speech
Pause mean	Average pause length in ms	Longer average pauses	Milliseconds
Longest Pause	Longest pause length in ms	Increased pause length	Milliseconds
Shortest Pause	Shortest pause length in ms	Increased pause length	Milliseconds
Utterance frequency	Total number of utterances (> 150 ms)	More utterances	# of utterances per 2 min. of speech

(table continues)

Variable	Description	Increasing scores reflect	Units of Measure
Utterance mean	Average utterance length in ms	Longer average utterances	Milliseconds
	Fundamental Frequency (F0)		
Inflection	Variability in pitch – both within utterance (i.e. locally) and across utterances (i.e. globally)	Greater variability in pitch	Decibels
F0 SD Local	Average S.D. of F0 values computed within each utterance	Higher F0 variability within utterances	Semitones, per second of average speech
F0 SD Global	S.D. of F0 values computed averaged across all utterances	Higher F0 variability within utterances	Semitones, per second of average speech
F0 Slope Mean	Average rate of change in pitch across speech sample	Greater variability in F0 across the sample	Semitones
F0 Perturbation	Absolute value of average change in consecutively voiced frames within utterance, averaged across utterances	Increasing levels of perturbation in F0 signal	Semitones
	First Format Frequency (F1)		
F1 Mean	Average F1 values computed within utterances and averaged across all utterances	Greater vowel articulation	Semitones
F1 SD Local	Average S.D. of F1 values computed within each utterance	Higher F1 variability within utterances	Semitones, per second of average speech
F1 SD Global	S.D. of F1 values computed averaged across all utterances	Higher F1 variability within utterances	Semitones, per second of average speech
F1 Slope Mean	Average rate of change in vowel articulation across speech sample	Greater variability in F1 across the sample	Semitones
	Second Format Frequency (F2)		
F2 Mean	Average F2 values computed within utterances and averaged across all utterances	Greater vowel articulation	Semitones
F2 SD Local	Average S.D. of F2 values computed within each utterance	Higher F2 variability within utterances	Semitones, per second of average speech
F2 SD Global	S.D. of F2 values computed averaged across all utterances	Higher F2 variability within utterances	Semitones, per second of average speech

(table continues)

Variable	Description	Increasing scores reflect	Units of Measure
F2 Slope Mean	Average rate of change in vowel articulation across speech sample	Greater variability in F2 across the sample	Semitones
		Intensity	
Amplitude	The mean volume	Greater volume	Decibels
Local Emphasis	S.D. of intensity values computed within each utterance and averaged across all utterances	Greater intensity variation within utterances	Decibels, per second of average speech
Global Emphasis	S.D. of intensity values averaged across all utterances	Greater intensity variation across utterances	Decibles, per second of average speech
Intensity Slope Mean	Average rate of change in volume across speech sample	Greater intensity variability across the sample	Decibels
Intensity Perturbation	Absolute value of average change in volume in consecutively voiced frames within utterance, averaged across utterances	Increasing levels of perturbation in the intensity signal	Decibels

Table 4

Psychopathy Checklist-Revised (PCL-R) Probes of Interest Varying on the Basis of Valence and Arousal for Speech Isolation

Probe of Interest (Valence_Arousal)	Begin Isolation	End Isolation
Positive_High	What do you think love is or what do you think love feels like?	Have you ever had a live-in or marital relationship?
Positive_Low	What are your main accomplishments?	What is your main weakness?
Neutral	What jobs have you had since the age of 18?	What was your favorite job?
Negative_High	What sorts of things make you angry?	Have you ever gotten in physical fights?
Negative_Low	What’s the saddest you’ve ever been?	Have you even been depressed?
Guilty	Is there anything you feel especially guilty about, even if it wasn’t a crime?	Have you ever violated probation or parole?

Table 5

Descriptive Statistics and Reliability Estimates for Valence and Arousal Ratings

Probe	Valence	Arousal	a
Neutral	5	5	1.00
Pos_High	8.94	6.91	.89
Pos_Low	8.01	4.03	1.00
Neg_High	3.02	7	.92
Neg_Low	2	4	1.00
Guilty	3.03	4.98	.80

Table 6

ANOVA Results for the Neutral Probe Examining Extreme Groups Differences in CANS Speech Variables

	PCL-R Low Group			PCL-R High Group			Diff	F (df, df)	p
	M	SD	r*	M	SD	r*			
Speech Production Variables									
Length of Recording	56646	27429.69	-.15	50261.84	26441.84	.04	L < H	F (1, 71) = 1.025	.32
Latency to First Utterance	2798.48	1663.08	-.04	3514.89	4627.25	.27*	L < H	F (1, 71) = .749	.39
Pause Mean	5623.58	4722.29	.16	5771.74	4322.70	.04	L < H	F (1, 71) = .231	.63
Utterance Frequency	30.63	20.10	-.06	26.34	16.73	.10	L > H	F (1, 71) = .986	.32
Utterance Mean	845.94	793.95	-.05	2115.65	7812.15	-.11	L < H	F (1, 71) = .915	.34
Shortest Pause	194.57	64.28	.21	244.47	300.05	-.17	L < H	F (1, 71) = .928	.34
Longest Pause	63618.00	27246.58	.15	69994.74	26430.07	-.04	L < H	F (1, 71) = 1.030	.31
Number of 500 ms Pauses	12.11	7.29	.05	11.97	9.36	.04	L > H	F (1, 71) = .005	.94
Number of 1000 ms Pauses	5.06	4.18	-.08	5.39	4.88	.000	L < H	F (1, 71) = .100	.75
Number of 5000 ms Pauses	.14	.494	-.30*	.18	.563	.33*	L < H	F (1, 71) = .111	.74

(table continues)

	PCL-R Low Group			PCL-R High Group			Diff	F (df, df)	p
	M	SD	r*	M	SD	r*			
				F0 Variables					
F0 Mean	82.68	2.18	.18	83.37	2.69	-.04	L < H	F (1, 71) = 1.410	.24
F0 SD Local	2.30	1.09	-.19	2.41	1.02	.16	L < H	F (1, 71) = .202	.65
F0 SD Global	1.53	.65	-.20	1.73	.82	-.06	L < H	F (1, 71) = 1.338	.25
F0 Slope Mean	-0.90	3.82	-.44**	1.08	5.21	.02	L < H	F (1, 71) = 3.370	*.07*
F0 Peturbation	.16	.05	-.01	.17	.06	.32*	L < H	F (1, 71) = .127	.72
				F1 Variables					
F1 Mean	107.67	1.40	-.36*	108.43	2.21	.14	L < H	F (1, 71) = 2.996	*.09*
F1 SD Local	5.24	3.23	.25	5.45	3.17	-.11	L < H	F (1, 71) = .079	.78
F1 SD Global	2.35	1.44	.12	2.15	1.18	-.22	L > H	F (1, 71) = .408	.53
F1 Slope Mean	.67	9.53	-.10	1.54	7.86	-.002	L < H	F (1, 71) = .182	.67
				F2 Variables					
F2 Mean	127.47	1.54	-.002	127.74	1.58	.21	L < H	F (1, 71) = .528	.47
F2 SD Local	3.21	.92	.30*	3.14	.80	-.31*	L > H	F (1, 71) = .121	.73

(table continues)

	PCL-R Low Group			PCL-R High Group			Diff	F (df, df)	p
	M	SD	r*	M	SD	r*			
F2 SD Global	1.27	.45	.15	1.18	.36	-.10	L > H	F (1, 71) = .816	.37
F2 Slope Mean	1.88	4.95	.18	.17	3.69	.13	L > H	F (1, 71) = 2.840	*.09*
Intensity Variables									
Intensity Mean	9.52	6.57	.08	6.94	5.33	-.18	L > H	F (1, 71) = 3.416	*.07*
Intensity SD Local	3.24	1.04	.08	3.01	.96	-.34	L > H	F (1, 71) = .978	.33
Intensity SD Global	1.46	.81	-.13	1.65	1.21	.05	L < H	F (1, 71) = .606	.44
Intensity Slope Mean	.99	.31	-.04	.98	.39	.05	L > H	F (1, 71) = .079	.78
Intensity Peturbation	.70	.18	-.04	.68	.21	-.01	L > H	F (1, 71) = .246	.62

Table 7

ANOVA Results for the Pos_High Probe Examining Extreme Groups Differences in CANS Speech Variables

	PCL-R Low Group			PCL-R High Group			Diff	F (df, df)	p
	M	SD	r*	M	SD	r*			
Speech Production Variables									
Length of Recording	34117.38	21796.36	.06	41140.45	24447.08	-.10	L < H	F (1, 84) = 1.971	.16
Latency to First Utterance	3474.73	2184.34	.05	3523.92	2748.43	-.18	L < H	F (1, 84) = .008	.93
Pause Mean	12189.88	13102.27	.07	7764.39	5925.75	.18	L > H	F (1, 84) = 4.133	.05*
Utterance Frequency	16.81	14.94	.09	20.59	15.30	-.06	L < H	F (1, 84) = 1.343	.25
Utterance Mean	1071.86	1608.90	.09	1641.29	4118.27	.02	L < H	F (1, 84) = .701	.41
Shortest Pause	404.05	843.70	.08	226.14	112.25	-.02	L > H	F (1, 84) = 1.922	.17
Longest Pause	86104.76	21843.08	-.05	79064.55	24446.40	.11	L > H	F (1, 84) = 1.977	.16
Number of 500 ms Pauses	7.19	6.33	.06	9.70	7.66	-.09	L < H	F (1, 84) = 2.739	.10
Number of 1000 ms Pauses	3.74	4.28	-.01	4.30	4.49	-.12	L < H	F (1, 84) = .346	.56
Number of 5000 ms Pauses	.19	.55	.11	.32	.83	.165	L < H	F (1, 84) = .701	.41

(table continues)

	PCL-R Low Group			PCL-R High Group			Diff	F (df, df)	p
	M	SD	r*	M	SD	r*			
				F0 Variables					
F0 Mean	83.28	2.76	.28*	83.31	3.61	.03	L < H	F (1, 84) = .002	.97
F0 SD Local	2.57	1.07	-.11	2.35	1.08	.06	L > H	F (1, 84) = .917	.34
F0 SD Global	1.70	.87	-.18	1.56	.64	-.06	L > H	F (1, 84) = .733	.39
F0 Slope Mean	.40	3.64	.10	.79	5.57	-.20	L < H	F (1, 84) = .141	.71
F0 Peturbation	.19	.11	-.02	.20	.09	-.07	L < H	F (1, 84) = .070	.79
				F1 Variables					
F1 Mean	107.67	1.93	-.41*	108.57	2.86	.194	L < H	F (1, 84) = 2.889	*.09*
F1 SD Local	5.17	3.71	.081	5.57	3.24	.057	L < H	F (1, 84) = .289	.59
F1 SD Global	1.85	1.10	.114	2.02	1.12	-.103	L < H	F (1, 84) = .516	.48
F1 Slope Mean	.44	8.70	-.045	3.00	9.96	.160	L < H	F (1, 84) = 1.617	.21
				F2 Variables					
F2 Mean	127.77	1.55	-.093	128.13	1.77	.215	L < H	F (1, 84) = 1.015	.32
F2 SD Local	3.15	1.02	.140	2.99	.77	-.018	L > H	F (1, 84) = .633	.43

(table continues)

	PCL-R Low Group			PCL-R High Group			Diff	F (df, df)	p
	M	SD	r*	M	SD	r*			
F2 SD Global	1.19	.59	-.049	1.07	.41	-.125	L > H	F (1, 84) = 1.365	.25
F2 Slope Mean	-0.67	5.68	-.045	1.63	4.05	.082	L < H	F (1, 84) = 4.718	.03*
Intensity Variables									
Intensity Mean	8.40	6.56	.136	6.66	5.68	-.105	L > H	F (1, 84) = 1.744	.19
Intensity SD Local	3.19	1.25	.076	2.99	1.13	-.182	L > H	F (1, 84) = .632	.43
Intensity SD Global	1.48	.76	-.247	1.38	.81	-.216	L > H	F (1, 84) = .358	.55
Intensity Slope Mean	.89	.42	.141	.90	.37	.021	L < H	F (1, 84) = .003	.96
Intensity Peturbation	.74	.25	-.004	.69	.24	-.072	L > H	F (1, 84) = .787	.38

Table 8

ANOVA Results for the Neg_High Probe Examining Extreme Groups Differences in CANS Speech Variables

	PCL-R Low Group			PCL-R High Group			Diff	F (df, df)	p
	M	SD	r*	M	SD	r*			
Speech Production Variables									
Length of Recording	64250.94	27561.09	-.09	64257.06	29748.60	.41*	L < H	F (1, 64) = .000	.99
Latency to First Utterance	5265.09	6105.81	-.05	3936.80	4019.41	.32*	L > H	F (1, 64) = 1.102	.30
Average Pause Length	5537.88	6618.15	-.01	6261.76	17444.71	-.19	L < H	F (1, 64) = .048	.83
Number of Utterances	31.47	21.50	-.09	35.09	20.22	.13	L < H	F (1, 64) = .497	.48
Average Length of Utterance	1013.59	1458.58	.11	1543.07	2989.42	.08	L < H	F (1, 64) = .820	.37
Shortest Pause	290.94	374.69	-.11	3270.88	17842.81	-.17	L < H	F (1, 64) = .891	.35
Longest Pause	56055.94	27526.45	.09	56288.82	29331.52	-.40*	L < H	F (1, 64) = .001	.97
Number of 500 ms Pauses	11.59	7.85	.20	14.41	7.68	.35*	L < H	F (1, 64) = 2.172	.15
Number of 1000 ms Pauses	5.03	4.60	.26	6.74	4.94	.26	L < H	F (1, 64) = 2.099	.15
Number of 5000 ms Pauses	.22	.61	.13	.47	1.26	.36*	L < H	F (1, 64) = 1.047	.31

(table continues)

	PCL-R Low Group			PCL-R High Group			Diff	F (df, df)	p
	M	SD	r*	M	SD	r*			
				F0 Variables					
F0 Mean	82.73	1.90	.15	83.80	3.20	-.09	L < H	F (1, 64) = 2.687	.11
F0 SD Local	2.27	.81	.04	2.55	1.15	.12	L < H	F (1, 64) = 1.269	.26
F0 SD Global	1.54	.61	-.33*	1.65	.64	-.22	L < H	F (1, 64) = .499	.48
F0 Slope Mean	-1.45	4.50	.21	-0.74	3.33	.25	L < H	F (1, 64) = .385	.55
F0 Peturbation	.18	.08	-.03	.20	.07	-.12	L < H	F (1, 64) = 1.289	.26
				F1 Variables					
F1 Mean	107.27	2.20	-.29	108.91	3.33	.04	L < H	F (1, 64) = 5.506	.02*
F1 SD Local	5.20	3.20	.29	5.60	3.19	-.04	L < H	F (1, 64) = .245	.62
F1 SD Global	2.26	1.24	.21	2.26	1.23	-.34*	L = H	F (1, 64) = .000	.99
F1 Slope Mean	-.79	5.55	-.13	2.80	9.09	.06	L < H	F (1, 64) = 3.663	*.06*
				F2 Variables					
F2 Mean	127.75	1.35	.09	128.45	1.73	-.02	L < H	F (1, 64) = 3.345	*.07*
F2 SD Local	2.99	.82	.31*	3.06	.82	.02	L < H	F (1, 64) = .102	.75

(table continues)

	PCL-R Low Group			PCL-R High Group			Diff	F (df, df)	p
	M	SD	r*	M	SD	r*			
F2 SD Global	1.21	.44	.05	1.12	.41	-.27	L > H	F (1, 64) = .663	.42
F2 Slope Mean	.41	4.18	.18	.87	3.65	.19	L < H	F (1, 64) = .333	.57
Intensity Variables									
Intensity Mean	8.09	6.33	.03	5.47	4.23	-.07	L < H	F (1, 64) = 3.955	.05*
Intensity SD Local	2.83	.92	.27	2.62	.81	-.09	L > H	F (1, 64) = .941	.34
Intensity SD Global	1.31	.44	.19	1.21	.42	-.02	L > H	F (1, 64) = .790	.38
Intensity Slope Mean	.89	.37	.20	.99	.36	-.29*	L < H	F (1, 64) = 1.186	.28
Intensity Peturbation	.71	.20	-.07	.67	.21	.01	L > H	F (1, 64) = .532	.47

Table 9

ANOVA Results for the Pos_Low Probe Examining Extreme Groups Differences in CANS Speech Variables

	PCL-R Low Group			PCL-R High Group			Diff	F (df, df)	p
	M	SD	r*	M	SD	r*			
Speech Production Variables									
Length of Recording	23692.42	12998.10	-.22	32903.00	24432.27	.19	L < H	F (1, 62) = 3.580	*.06*
Latency to First Utterance	3756.96	2802.50	-.30*	2861.18	1872.22	.06	L > H	F (1, 62) = 2.179	.15
Pause Mean	18187.41	20545.91	.15	16276	26615.37	.03	L > H	F (1, 62) = .103	.75
Utterance Frequency	11.67	10.12	-.20	18.50	15.92	.22	L < H	F (1, 62) = 4.212	.04*
Utterance Mean	846.99	707.60	.26	1822.15	3398.78	.12	L < H	F (1, 62) = 2.597	.11
Shortest Pause	3710.00	19176.91	.15	7380.67	27036.20	.08	L < H	F (1, 62) = .392	.53
Longest Pause	96681.82	13060.02	.22	87377.33	24512.88	-.18	L > H	F (1, 62) = 3.626	*.06*
Number of 500 ms Pauses	5.48	4.71	-.05	7.50	6.27	.13	L < H	F (1, 62) = 2.102	.15
Number of 1000 ms Pauses	2.48	2.45	-.02	3.53	3.40	.01	L < H	F (1, 62) = 1.997	.16
Number of 5000 ms Pauses	.03	.17	.08	.23	.43	-.02	L < H	F (1, 62) = 6.236	.01**

(table continues)

	PCL-R Low Group			PCL-R High Group			Diff	F (df, df)	p
	M	SD	r*	M	SD	r*			
				F0 Variables					
F0 Mean	82.86	2.48	-.16	83.32	2.49	.08	L < H	F (1, 62) = .528	.47
F0 SD Local	2.60	1.12	.07	2.38	.99	.37*	L > H	F (1, 62) = .650	.42
F0 SD Global	1.62	.89	-.32*	1.62	.59	.52**	L = H	F (1, 62) = .000	.99
F0 Slope Mean	-1.74	7.22	.27	-.62	4.14	.09	L < H	F (1, 62) = .525	.47
F0 Peturbation	.18	.05	-.06	.18	.05	.12	L = H	F (1, 62) = .013	.91
				F1 Variables					
F1 Mean	107.79	2.24	-.30*	109.35	3.13	.11	L < H	F (1, 62) = 5.245	.03*
F1 SD Local	4.59	3.25	.28	5.78	3.50	-.03	L < H	F (1, 62) = 1.887	.18
F1 SD Global	1.68	1.14	.17	2.35	1.35	-.23	L < H	F (1, 62) = 4.320	.04*
F1 Slope Mean	-.22	6.87	.04	.30	9.40	-.14	L < H	F (1, 62) = .060	.81
				F2 Variables					
F2 Mean	127.66	1.44	.11	128.74	1.71	.17	L < H	F (1, 62) = 7.401	.01*
F2 SD Local	2.86	.82	.32*	2.95	.95	-.10	L < H	F (1, 62) = .155	.70

(table continues)

	PCL-R Low Group			PCL-R High Group			Diff	F (df, df)	p
	M	SD	r*	M	SD	r*			
F2 SD Global	.98	.41	.06	1.07	.40	-.10	L < H	F (1, 62) = .640	.43
F2 Slope Mean	-.59	5.57	.28	.44	4.14	-.15	L < H	F (1, 62) = .648	.42
Intensity Variables									
Intensity Mean	6.93	7.25	-.20	5.19	4.75	-.30*	L > H	F (1, 62) = 1.253	.27
Intensity SD Local	2.92	1.15	.08	2.78	1.03	-.46**	L > H	F (1, 62) = .229	.63
Intensity SD Global	1.47	.89	-.14	1.39	.59	-.24	L > H	F (1, 62) = .159	.69
Intensity Slope Mean	.80	.44	-.08	.97	.36	.02	L < H	F (1, 62) = 2.565	.12
Intensity Peturbation	.69	.20	-.17	.65	.23	-.16	L > H	F (1, 62) = .692	.41

Table 10

ANOVA Results for the Neg_Low Probe Examining Extreme Groups Differences in CANS Speech Variables

	PCL-R Low Group			PCL-R High Group			Diff	F (df, df)	p
	M	SD	r*	M	SD	r*			
Speech Production Variables									
Length of Recording	39113.25	23730.54	-.38*	35562.75	17560.50	-.13	L > H	F (1, 78) = .579	.45
Latency to First Utterance	3879.48	2871.84	-.47*	4294.73	3742.52	.33*	L < H	F (1, 78) = .310	.58
Pause Mean	9573.84	8067.54	.22	12237.60	19701.15	.48**	L < H	F (1, 78) = .626	.43
Utterance Frequency	19.00	16.33	-.34*	17.95	11.60	-.17	L > H	F (1, 78) = .110	.74
Utterance Mean	1008.01	1560.48	.12	1681.29	4411.41	.34*	L < H	F (1, 78) = .828	.37
Shortest Pause	245.75	107.89	.30*	4747.50	20250.91	.50**	L < H	F (1, 78) = 1.977	.16
Longest Pause	81300.50	23871.61	.38*	84684.25	17526.92	.14	L < H	F (1, 78) = .522	.47
Number of 500 ms Pauses	7.25	6.76	-.34*	7.53	5.80	-.33*	L < H	F (1, 78) = .038	.85
Number of 1000 ms Pauses	3.48	3.78	-.23	3.70	3.71	-.26	L < H	F (1, 78) = .072	.79
Number of 5000 ms Pauses	.18	.59	.13	.18	.45	.09	L = H	F (1, 78) = .000	1.00

(table continues)

	PCL-R Low Group			PCL-R High Group			Diff	F (df, df)	p
	M	SD	r*	M	SD	r*			
				F0 Variables					
F0 Mean	83.16	3.07	.15	83.34	3.18	.01	L < H	F (1, 78) = .066	.80
F0 SD Local	2.34	1.17	.18	2.66	1.22	.19	L < H	F (1, 78) = 1.381	.24
F0 SD Global	1.61	.71	-.13	1.66	.76	.03	L < H	F (1, 78) = .105	.75
F0 Slope Mean	-1.57	7.65	-.36*	-.74	3.48	-.02	L < H	F (1, 78) = .367	.55
F0 Peturbation	.21	.16	-.03	.20	.07	-.07	L > H	F (1, 78) = .-46	.83
				F1 Variables					
F1 Mean	107.89	2.16	-.14	108.38	2.70	.27*	L < H	F (1, 78) = .810	.37
F1 SD Local	5.14	3.72	.29*	5.62	3.54	-.18	L < H	F (1, 78) = .348	.56
F1 SD Global	1.93	1.15	.17	1.99	1.42	-.17	L < H	F (1, 78) = .055	.82
F1 Slope Mean	3.83	14.67	.05	3.97	13.40	-.05	L < H	F (1, 78) = .002	.97
				F2 Variables					
F2 Mean	127.72	1.52	.13	128.20	1.81	.17	L < H	F (1, 78) = 1.599	.21
F2 SD Local	2.88	.82	.28*	2.95	.82	-.20	L < H	F (1, 78) = .155	.70

(table continues)

	PCL-R Low Group			PCL-R High Group			Diff	F (df, df)	p
	M	SD	r*	M	SD	r*			
F2 SD Global	1.07	.47	.11	1.08	.43	.02	L < H	F (1, 78) = .019	.89
F2 Slope Mean	1.35	8.15	.38*	.98	7.31	-.14	L < H	F (1, 78) = .042	.84
Intensity Variables									
Intensity Mean	7.78	7.78	.14	6.23	5.86	-.20	L > H	F (1, 78) = .195	.66
Intensity SD Local	2.74	1.17	.25	2.63	1.07	-.24	L > H	F (1, 78) = 1.012	.32
Intensity SD Global	1.18	.65	.10	1.12	.49	-.23	L > H	F (1, 78) = .194	.66
Intensity Slope Mean	.87	.40	-.12	.94	.35	-.14	L < H	F (1, 78) = .744	.39
Intensity Peturbation	.69	.28	.09	.67	.26	-.04	L > H	F (1, 78) = .184	.67

Table 11

ANOVA Results for the Guilty Probe Examining Extreme Groups Differences in CANS Speech Variables

	PCL-R Low Group			PCL-R High Group			Diff	F (df, df)	p
	M	SD	r*	M	SD	r*			
Speech Production Variables									
Length of Recording	29850.61	16119.98	.05	36203.95	23749.21	.03	L < H	F (1, 69) = 1.591	.21
Latency to First Utterance	3400.92	2141.69	.01	3018.13	2004.99	.04	L > H	F (1, 69) = .604	.44
Pause Mean	13495.89	14822.25	.12	12987.13	20023.13	-.16	L > H	F (1, 69) = .014	.91
Utterance Frequency	15.21	12.75	.09	19.16	17.30	-.06	L < H	F (1, 69) = 1.166	.28
Utterance Mean	864.13	954.32	.03	1333.77	1755.14	.01	L < H	F (1, 69) = 1.878	.18
Shortest Pause	800.61	2146.81	.13	3376.58	18820.84	-.15	L < H	F (1, 69) = .610	.44
Longest Pause	90413.03	16325.87	-.05	84330.00	23978.28	-.03	L > H	F (1, 69) = 1.513	.22
Number of 500 ms Pauses	6.42	5.64	.09	8.00	7.28	-.06	L < H	F (1, 69) = 1.017	.32
Number of 1000 ms Pauses	3.18	3.18	.03	4.08	4.15	-.01	L < H	F (1, 69) = 1.022	.32
Number of 5000 ms Pauses	.09	.29	-.01	.29	.73	.25	L < H	F (1, 69) = 2.131	.15

(table continues)

	PCL-R Low Group			PCL-R High Group			Diff	F (df, df)	p
	M	SD	r*	M	SD	r*			
				F0 Variables					
F0 Mean	82.96	3.45	.07	84.12	3.80	-.02	L < H	F (1, 69) = 1.814	.18
F0 SD Local	2.39	1.09	.17	2.41	1.09	.10	L < H	F (1, 69) = .002	.96
F0 SD Global	1.60	.87	.15	1.50	.69	-.02	L > H	F (1, 69) = .292	.59
F0 Slope Mean	-.21	6.04	.20	.56	4.06	-.04	L < H	F (1, 69) = .395	.53
F0 Peturbation	.22	.16	-.03	.21	.10	-.07	L > H	F (1, 69) = .030	.86
				F1 Variables					
F1 Mean	107.85	2.35	-.11	109.32	4.08	.11	L < H	F (1, 69) = 3.319	*.07*
F1 SD Local	4.49	2.94	.13	6.06	3.76	-.04	L < H	F (1, 69) = 3.546	*.06*
F1 SD Global	1.79	1.12	.14	1.89	.99	-.38*	L < H	F (1, 69) = .174	.68
F1 Slope Mean	-.59	6.69	.05	2.97	10.73	.02	L < H	F (1, 69) = 2.560	.11
				F2 Variables					
F2 Mean	127.54	1.78	.09	128.69	1.95	.10	L < H	F (1, 69) = 6.685	.01*
F2 SD Local	2.86	.88	.04	3.07	.96	-.14	L < H	F (1, 69) = .868	.36

(table continues)

	PCL-R Low Group			PCL-R High Group			Diff	F (df, df)	p
	M	SD	r*	M	SD	r*			
F2 SD Global	1.04	.37	.08	.94	.41	-.12	L > H	F (1, 69) = .961	.33
F2 Slope Mean	-.64	5.23	.12	.96	7.88	.22	L < H	F (1, 69) = .930	.34
Intensity Variables									
Intensity Mean	7.31	7.27	.18	5.09	5.90	-.22	L > H	F (1, 69) = 2.017	.16
Intensity SD Local	2.74	1.04	.10	2.91	1.32	-.30*	L < H	F (1, 69) = .356	.55
Intensity SD Global	1.22	.56	.05	1.47	.99	.11	L < H	F (1, 69) = 1.523	.22
Intensity Slope Mean	.87	.36	.05	.77	.46	-.10	L > H	F (1, 69) = 1.022	.32
Intensity Peturbation	.73	.29	.06	.69	.32	-.15	L > H	F (1, 69) = .305	.58

Table 12

PCL-R Total Score and Facets Correlated with CANS Variables in Positive Valence, High Arousal Probe in Psychopathic and Non-Psychopathic Groups

CANS Variables	Psychopathic Group (n = 46)					Non-Psychopathic Group (n = 43)				
	INT	AFF	LIFE	ANTI	TOTAL	INT	AFF	LIFE	ANTI	TOTAL
Silence Percent	-0.09	0.03	-0.01	0.11	-0.02	0.27*	-0.14	0.26*	-0.10	0.10
Latency to 1st Utter.	-0.40**	0.07	0.01	0.25*	-0.14	-0.02	0.10	0.09	0.01	0.06
Pause Mean	0.14	0.06	0.04	-0.03	0.15	-0.30*	0.15	-0.11	0.10	-0.02
Utterance Number	0.02	0	0.05	0.03	0.04	0.35*	-0.13	0.28*	-0.11	0.13
Utterance Mean	0.15	0.21	0.08	-0.15	0.01	-0.14	0.05	0.20	-0.01	0.11
Shortest Pause	0.19	0.25*	-0.05	-0.17	0.01	-0.24	0.02	0	0.17	0.07
Longest Pause	0.05	-0.14	-0.05	-0.05	0.05	-0.28*	0.15	-0.28*	0.10	-0.11
Number 500 Pauses	-0.06	0.06	-0.01	0.07	0.01	0.22	-0.22	0.23	0.02	0.11
Number 1000 Pauses	-0.14	0.09	0.07	0.06	-0.02	0.15	-0.13	0.16	-0.05	0.03
Number 5000 Pauses	-0.04	0.16	0.14	0.13	0.14	0.09	0.03	0.09	-0.02	0.13
F0 Mean	-0.28*	0.15	0.11	0.19	0.03	0.12	0.41**	0.05	0.04	0.28*
F0 SD Local	-0.14	0.27*	0.10	0.11	0.14	-0.19	0.12	-0.08	0.002	-0.13
F0 SD Global	-0.10	0.14	0.05	-0.01	0.02	-0.05	0.11	-0.20	-0.05	-0.20
F0 Slope Mean	-0.28*	-0.06	0.27	0.04	-0.19	0.13	0.27*	-0.07	-0.27*	-0.05
F0 Peturbation	-0.05	-0.001	0.17	0.15	0.19	-0.10	-0.01	0.02	-0.17	-0.21
F1 Mean	0.07	0.23	0.21	-0.01	0.19	-0.19	-0.29*	-0.28*	0.04	-0.41**
F1 SD Local	-0.01	-0.14	0.14	0.07	0.01	-0.18	0.21	-0.10	0.29*	0.12
F1 SD Global	0.03	-0.21	-0.04	-0.002	-0.09	0.08	0.25*	-0.09	0.15	0.17

(table continues)

CANS Variables	Psychopathic Group (n = 46)					Non-Psychopathic Group (n = 43)				
	INT	AFF	LIFE	ANTI	TOTAL	INT	AFF	LIFE	ANTI	TOTAL
F1 Slope Mean	0.16	-0.04	-0.001	-0.01	0.16	0.07	-0.07	-0.17	0.10	-0.01
F2 Mean	0.03	0.01	0.20	0.11	0.20	-0.04	0.06	-0.24	0.23	-0.05
F2 SD Local	-0.14	-0.09	0.19	0.03	-0.09	-0.08	0.06	0.08	0.13	0.20
F2 SD Global	0.03	0.12	-0.07	-0.20	-0.11	0.18	-0.14	-0.03	0.001	-0.004
F2 Slope Mean	0.21	-0.19	-0.04	-0.04	0.07	-0.08	0.03	-0.25*	0.25*	-0.06
Intensity Mean	-0.01	-0.06	0.05	-0.14	-0.13	0.06	-0.02	0.12	0.06	0.16
Intensity SD Local	-0.06	0.12	0.08	-0.27*	-0.18	-0.08	-0.06	0.14	0.09	0.13
Intensity SD Global	-0.01	0.11	-0.10	-0.23	-0.21	-0.11	-0.13	-0.07	0.10	-0.19
Intensity Slope Mean	0.05	-0.14	0.06	-0.07	0.04	0.35*	0.10	0.05	-0.15	0.16
Intensity Peturbation	0.06	0.03	0.02	-0.10	-0.02	0.12	0.02	0.13	-0.20	0.02

**$p < .001$; *$p < .05$

Table 13

PCL-R Total Score and Facets Correlated with CANS Variables in Positive Valence, Low Arousal Probe in Psychopathic and Non-Psychopathic Groups

CANS Variables	Psychopathic Group (*n* = 44)					Non-Psychopathic Group (*n* = 40)				
	INT	AFF	LIFE	ANTI	TOTAL	INT	AFF	LIFE	ANTI	TOTAL
Silence Percent	0.19	0.08	-0.16	0.11	0.22	0.23	-0.36*	0.09	-0.24	-0.23
Latency to 1st Utter.	0.17	-0.01	-0.07	0.04	0.16	0.02	-0.39**	-0.03	0.17	-0.25*
Pause Mean	-0.07	0.13	0.21	0.02	0.04	0.02	0.15	-0.05	0.17	0.16
Utterance Number	0.23	0.08	-0.09	0.08	0.26*	0.27*	-0.18	0.10	-0.24	-0.14

(table continues)

CANS Variables	Psychopathic Group (n = 44)					Non-Psychopathic Group (n = 40)				
	INT	AFF	LIFE	ANTI	TOTAL	INT	AFF	LIFE	ANTI	TOTAL
Utterance Mean	0.17	0.07	0.02	0.13	0.17	0.12	0.18	-0.11	0.22	0.30*
Shortest Pause	-0.02	0.10	0.22	0.03	0.08	0.13	0.06	0.14	0.10	0.20
Longest Pause	-0.21	-0.08	0.17	-0.11	-0.22	-0.31*	0.33*	-0.11	0.22	0.14
Number 500 Pauses	0.19	0.08	-0.12	0.06	0.19	0.34*	-0.23	0.12	-0.19	-0.003
Number 1000 Pauses	0.13	0.10	-0.17	-0.02	0.07	0.30*	-0.30*	0.06	-0.12	0.02
Number 5000 Pauses	0.22	-0.07	-0.01	-0.003	0.10	-0.16	0.29*	-0.24	0.17	0.08
F0 Mean	-0.15	0.06	-0.04	0.08	-0.01	-0.02	0.18	-0.19	0.07	-0.15
F0 SD Local	-0.05	0.19	0.08	0.12	0.12	-0.10	0.19	-0.15	0.01	-0.01
F0 SD Global	0.13	0.42	0.14	-0.09	0.42**	0.06	-0.07	-0.15	-0.14	-0.35*
F0 Slope Mean	-0.18	0.11	-0.09	0.16	-0.01	0.25*	0.12	0.06	-0.55**	-0.02
F0 Peturbation	0.01	-0.06	0.04	-0.23	-0.10	0.22	0.29*	-0.05	-0.01	0.07
F1 Mean	0.28*	0.08	0.06	-0.20	0.11	-0.11	-0.08	-0.14	-0.18	-0.26*
F1 SD Local	-0.13	-0.24	0.12	0.11	-0.13	0.22	0.40**	-0.13	0.10	0.27*
F1 SD Global	0.16	-0.44**	-0.03	-0.02	-0.17	0.15	0.29*	0.18	0.13	0.21
F1 Slope Mean	-0.31*	0.15	-0.08	0.07	-0.22	-0.08	0.12	0.03	0.23	0.14
F2 Mean	0.05	-0.01	0.18	0.04	0.17	0.28*	0.21	-0.20	0.12	0.06
F2 SD Local	-0.16	-0.35*	0.25*	0.18	-0.17	0.12	0.21	0.03	-0.08	0.28*
F2 SD Global	0.17	-0.17	-0.15	0.11	-0.03	0.04	0.002	0.24	-0.07	0.08
F2 Slope Mean	-0.29*	0.01	0.13	0.15	-0.17	0.01	0.29*	0.03	-0.10	0.21
Intensity Mean	-0.01	-0.10	-0.12	-0.09	-0.17	-0.12	-0.17	-0.04	0.15	-0.12
Intensity SD Local	-0.20	-0.35	0.09	-0.01	-0.37*	0.11	0.08	-0.07	0.06	0.13
Intensity SD Global	-0.05	-0.08	0.21	-0.02	0.01	0.08	0.19	-0.26*	-0.26*	-0.16

(table continues)

CANS Variables	Psychopathic Group (n = 44)					Non-Psychopathic Group (n = 40)				
	INT	AFF	LIFE	ANTI	TOTAL	INT	AFF	LIFE	ANTI	TOTAL
Intensity Slope Mean	0.23	0.03	-0.17	-0.11	0.09	0.09	-0.03	-0.09	0.11	-0.03
Intensity Peturbation	0.11	-0.12	0.04	-0.17	-0.10	-0.14	0.07	0.09	0.05	-0.01

**p < .001; *p < .05

Table 14

PCL-R Total Score and Facets Correlated with CANS Variables in Negative Valence, High Arousal Probe in Psychopathic and Non-Psychopathic Groups

CANS Variables	Psychopathic Group (n = 45)					Non-Psychopathic Group (n = 43)				
	INT	AFF	LIFE	ANTI	TOTAL	INT	AFF	LIFE	ANTI	TOTAL
Silence Percent	-0.24	0.11	-0.22	0.06	-0.10	0.12	-0.15	-0.04	-0.06	-0.17
Latency to 1st Utter.	0.01	0.06	-0.13	0.30*	0.21	0.09	-0.17	0.11	0.05	0.02
Pause Mean	0.19	0.15	0.02	-0.25*	-0.14	-0.22	0.23	-0.26*	0.16	0.07
Utterance Number	-0.08	0.15	-0.20	-0.10	-0.01	0.19	-0.11	0.03	-0.20	-0.14
Utterance Mean	0.18	0.25*	0.13	-0.11	0.11	-0.10	0.11	-0.03	-0.02	0.06
Shortest Pause	0.15	0.22	-0.01	-0.26*	-0.14	-0.12	-0.11	-0.13	-0.06	-0.05
Longest Pause	0.21	-0.21	0.04	-0.10	-0.13	-0.19	0.19	-0.01	0.21	0.22
Number 500 Pauses	-0.11	0.28*	-0.04	-0.10	0.13	0.14	-0.10	0.05	-0.21	-0.11
Number 1000 Pauses	-0.16	0.22	0.10	-0.03	0.12	0.15	-0.16	0.04	-0.26*	-0.16
Number 5000 Pauses	-0.03	0.16	0.31*	0.17	0.36**	-0.03	-0.06	0.09	0.002	0.04
F0 Mean	-0.28*	0.03	0.10	0.12	-0.07	0.11	0.25*	-0.09	-0.01	0.01
F0 SD Local	-0.13	0.17	0.26*	0.13	0.16	-0.004	0.40**	-0.23	0.01	0.03

(table continues)

CANS Variables	Psychopathic Group (n = 45)					Non-Psychopathic Group (n = 43)				
	INT	AFF	LIFE	ANTI	TOTAL	INT	AFF	LIFE	ANTI	TOTAL
F0 SD Global	-0.04	0.03	-0.05	-0.07	-0.14	0.07	0.01	-0.15	0.003	-0.19
F0 Slope Mean	0.07	-0.11	0.10	0.02	0.13	0.16	0.25	-0.12	-0.25*	0.06
F0 Peturbation	-0.002	0.23	0.06	0.12	0.24	-0.07	0.09	-0.01	-0.09	-0.09
F1 Mean	0.26*	0.27*	0.10	-0.18	0.12	-0.06	-0.30*	-0.20	-0.17	-0.30*
F1 SD Local	-0.25*	-0.06	0.13	0.28*	0.03	-0.01	0.32*	0.01	0.12	0.28*
F1 SD Global	-0.35*	-0.17	-0.02	0.19	-0.24	0.06	0.19	-0.01	0.17	0.23
F1 Slope Mean	-0.19	0.10	0.05	0.22	0.13	-0.34*	0.02	0.10	0.004	-0.12
F2 Mean	0.04	0.14	0.09	0.02	0.09	0.15	0.21	-0.12	0.09	0.15
F2 SD Local	-0.17	-0.17	0.30*	0.21	-0.01	0.05	0.14	0.04	-0.05	0.24
F2 SD Global	-0.03	-0.11	-0.12	-0.12	-0.30*	0.11	0.07	-0.01	-0.03	0.05
F2 Slope Mean	0.04	-0.13	0.22	0.18	0.27*	-0.10	0.02	0.01	0.05	0.23
Intensity Mean	-0.07	-0.14	0.02	-0.18	-0.19	0.04	-0.03	0.09	0.06	0.11
Intensity SD Local	-0.11	-0.09	0.21	-0.11	-0.11	0.08	0.16	-0.05	0.002	0.20
Intensity SD Global	-0.27*	0.13	0.13	0.03	-0.03	-0.05	0.13	-0.08	0.05	0.19
Intensity Slope Mean	-0.01	-0.06	-0.29*	-0.12	-0.26*	0.12	0.12	0.13	-0.02	0.09
Intensity Peturbation	0.01	-0.05	0.13	-0.10	-0.02	-0.02	0.11	0.08	-0.10	0

**p < .001; *p < .05

Table 15

PCL-R Total Score and Facets Correlated with CANS Variables in Negative Valence, Low Arousal Probe in Psychopathic and Non-Psychopathic Groups

CANS Variables	Psychopathic Group (*n* = 47)					Non-Psychopathic Group (*n* = 42)				
	INT	AFF	LIFE	ANTI	TOTAL	INT	AFF	LIFE	ANTI	TOTAL
Silence Percent	0.01	-0.13	-0.10	0.14	0.01	0.09	-0.24	-0.02	-0.20	-0.37*
Latency to 1st Utter.	0.14	-0.03	0.19	0.10	0.35*	-0.02	-0.06	-0.14	-0.17	-0.45**
Pause Mean	0.12	0.29*	0.22	-0.05	0.25*	-0.23	0.003	0.07	0.24	0.25*
Utterance Number	0.13	-0.22	-0.09	0.06	-0.03	0.02	-0.15	0.03	-0.25*	-0.35*
Utterance Mean	0.13	0.05	0.19	0.10	0.27*	-0.02	0.06	0.11	-0.02	0.11
Shortest Pause	0.15	0.27*	0.21	-0.02	0.27*	-0.05	-0.02	0.16	0.13	0.29*
Longest Pause	-0.05	0.23	0.02	-0.12	0.01	-0.12	0.23	-0.002	0.26*	0.38**
Number 500 Pauses	0.04	-0.27*	0.06	-0.003	-0.12	0.16	-0.23	0.02	-0.29*	-0.35*
Number 1000 Pauses	0.05	-0.24	0.08	-0.01	-0.09	0.25*	-0.25*	0.04	-0.21	-0.25*
Number 5000 Pauses	0.05	0.03	0.07	0.06	0.04	-0.09	0.07	0.13	0.01	0.12
F0 Mean	-0.26*	0.09	0.15	0.14	-0.02	0.04	0.36*	-0.01	0.03	0.13
F0 SD Local	-0.27*	0.32*	0.16	0.26*	0.14	-0.26*	0.21	0.15	0.05	0.17
F0 SD Global	-0.04	0.33*	-0.17	0.10	0.09	-0.14	0.09	-0.13	0.05	-0.12
F0 Slope Mean	0.09	-0.21	0.04	0.09	0.003	-0.02	-0.17	-0.24	0.03	-0.37*
F0 Peturbation	-0.11	0.14	-0.09	0.10	0.06	-0.01	0.06	0.23	-0.11	0.05
F1 Mean	0.12	0.13	0.17	-0.12	0.09	-0.08	-0.27*	0.08	-0.17	-0.16
F1 SD Local	-0.25*	-0.22	0.05	0.15	-0.21	0.05	0.27*	-0.03	0.17	0.26*
F1 SD Global	0.04	-0.23	-0.18	0.02	-0.20	0.06	0.15	0.14	-0.04	0.15

(table continues)

CANS Variables	Psychopathic Group (n = 47)					Non-Psychopathic Group (n = 42)				
	INT	AFF	LIFE	ANTI	TOTAL	INT	AFF	LIFE	ANTI	TOTAL
F1 Slope Mean	0.08	-0.08	-0.25*	-0.08	-0.07	-0.15	0.02	0.18	-0.01	0.04
F2 Mean	-0.06	0.01	0.17	0.10	0.06	0.15	0.07	-0.05	0.18	0.12
F2 SD Local	-0.21	-0.14	0.31*	0.03	-0.12	0.13	0.28*	0.03	-0.03	0.28*
F2 SD Global	0.14	0.001	-0.08	0.05	0.09	0.10	0.003	0.11	0.06	0.15
F2 Slope Mean	-0.08	0.09	-0.17	-0.01	-0.12	-0.05	0.32*	0.24	-0.01	0.40**
Intensity Mean	-0.01	-0.10	0.09	-0.23	-0.15	-0.001	0.14	0.06	0.03	0.15
Intensity SD Local	-0.13	-0.12	0.15	-0.14	-0.18	-0.02	0.23	-0.04	0.15	0.25
Intensity SD Global	-0.11	0.04	-0.12	0.01	-0.11	-0.10	-0.06	0.14	-0.05	0.09
Intensity Slope Mean	0.26*	-0.16	-0.17	-0.14	-0.07	0.01	-0.02	0.02	0.05	-0.03
Intensity Peturbation	0.03	-0.07	0.13	-0.15	-0.03	-0.09	0.20	0.21	-0.05	0.12

**p < .001; *p < .05

Table 16

PCL-R Total Score and Facets Correlated with CANS Variables in Neutral Probe in Psychopathic and Non-Psychopathic Groups

CANS Variables	Psychopathic Group (n = 48)					Non-Psychopathic Group (n = 43)				
	INT	AFF	LIFE	ANTI	TOTAL	INT	AFF	LIFE	ANTI	TOTAL
Silence Percent	0.51**	-0.32*	-0.21	-0.36*	-0.05	0.29*	-0.08	0.16	-0.33*	-0.12
Latency to 1st Utter.	0.16	0.03	0.01	0.07	0.26*	-0.01	-0.28*	-0.02	-0.01	-0.05
Pause Mean	-0.38**	0.36*	0.05	0.28	0.09	-0.21	-0.11	-0.20	0.23	-0.07
Utterance Number	0.52**	-0.36*	-0.12	-0.36*	-0.004	0.22	0.004	0.12	-0.31*	-0.09
Utterance Mean	0.14	0.23	0.02	-0.20	-0.10	-0.16	0.16	-0.20	0.07	-0.02

(table continues)

CANS Variables	Psychopathic Group (n = 48)					Non-Psychopathic Group (n = 43)				
	INT	AFF	LIFE	ANTI	TOTAL	INT	AFF	LIFE	ANTI	TOTAL
Shortest Pause	0.10	0.22	-0.02	-0.21	-0.15	-0.15	-0.19	-0.13	0.09	-0.15
Longest Pause	-0.52**	0.26*	0.12	0.40**	0.06	-0.23	0.05	-0.16	0.38**	0.14
Number 500 Pauses	0.40**	-0.35*	-0.09	-0.31	-0.07	0.20	-0.04	0.23	-0.34*	0
Number 1000 Pauses	0.09	-0.20	0.05	-0.08	-0.08	0.18	-0.09	0.18	-0.30*	-0.04
Number 5000 Pauses	0.004	0.22	0.27*	0.12	0.30*	-0.27*	0.15	-0.24	-0.02	-0.23
F0 Mean	-0.24	0.12	0.04	0.17	-0.03	0.09	0.30*	0.10	0.004	0.14
F0 SD Local	-0.38**	0.26*	0.10	0.27*	0.12	-0.08	0.25*	-0.06	-0.06	-0.09
F0 SD Global	-0.29*	0.08	-0.08	0.15	-0.07	0.01	-0.02	-0.03	0.05	-0.10
F0 Slope Mean	-0.16	0.09	0.04	0.09	0.03	0.05	-0.25*	-0.33*	-0.02	-0.35*
F0 Peturbation	-0.05	0.16	0.11	0.17	0.29*	-0.16	0.32*	-0.14	0.004	-0.001
F1 Mean	0.14	0.24	0.17	-0.07	0.20	-0.04	-0.31*	-0.13	-0.07	-0.24
F1 SD Local	-0.13	-0.08	0.16	0.12	-0.03	-0.09	0.30*	-0.06	0.27*	0.23
F1 SD Global	-0.21	-0.36*	0.11	0.15	-0.13	-0.04	0.23	-0.02	0.17	0.15
F1 Slope Mean	-0.25*	0.08	0.21	0.09	-0.01	0.02	0.02	-0.13	0.08	-0.07
F2 Mean	0.09	0.03	0.14	0.12	0.24	-0.08	0.28*	-0.16	0.14	0.01
F2 SD Local	-0.27*	-0.04	0.19	0.05	-0.28*	0.03	0.14	0.10	0.17	0.32*
F2 SD Global	-0.05	-0.16	-0.02	-0.01	-0.12	0.11	-0.05	0.20	0.03	0.20
F2 Slope Mean	0.09	0.02	0.02	0.002	0.08	0.14	0.10	-0.16	-0.04	0.15
Intensity Mean	-0.004	-0.10	-0.04	-0.21	-0.21	0.11	-0.12	0.17	-0.002	0.12
Intensity SD Local	-0.31*	0.06	0.08	-0.10	-0.33*	0.02	0.08	-0.08	0.01	0.11
Intensity SD Global	-0.16	0.05	0.10	0.06	0.06	-0.10	0.06	-0.20	-0.01	-0.08
Intensity Slope Mean	0.04	-0.16	-0.07	0.04	0.05	0.06	-0.08	0.16	-0.10	0.02
Intensity Peturbation	-0.06	0.06	-0.04	-0.03	-0.07	0.01	0.19	0.002	-0.13	-0.04

**p < .001; *p < .05

Table 17

Within-Subjects MANOVA Examining Group Differences in Psychopathic and Non-Psychopathic Offenders Across Valence and Arousal

CANS Variable	*n*	Group		Valence		Arousal		Group x Valence		Group x Arousal		Valence x Arousal		Group x Valence x Arousal	
		F	*p*	*F*	*p*	*F*	*p*	*F*	*p*	*F*	*p*	*F*	*p*	*F*	*p*
Length of Recording	80	.19	.66	64.02	.001**	33.89	.001**	1.35	.25	.01	.94	13.76	.001**	.56	.47
Silence Percent	80	.31	.58	99.82	.001**	56.72	.001**	6.65	.01*	.18	.67	16.79	.001**	.03	.85
Latency to 1st Utter.	80	.90	.35	7.68	.01*	1.57	.21	.07	.79	.23	.63	.55	.46	.71	.40
Pause Mean	79	.26	.61	23.36	.001**	26.95	.001**	3.56	*.06*	2.63	.11	1.65	.20	.02	.89
Utterance Frequency	80	1.04	.31	63.21	.001**	40.30	.001**	1.74	.19	.48	.49	21.82	.001**	.02	.89
Utterance Mean	79	1.25	.27	.02	.88	.00	.99	.08	.78	.32	.57	1.86	.18	.22	.64
Shortest Pause	79	1.23	.27	.56	.46	6.21	.02	1.48	.23	.91	.34	2.29	.13	.13	.72
Longest Pause	79	.30	.59	88.70	.001**	62.36	.001**	4.88	.03*	.39	.54	17.81	.001**	.45	.51
# of 500 ms Pauses	79	1.20	.28	50.06	.001**	39.76	.001**	1.34	.25	.23	.63	18.60	.001**	1.48	.23
# of 1000 ms Pauses	79	.26	.61	38.80	.001**	25.38	.001**	.63	.43	.02	.89	11.85	.001**	.38	.54
# of 5000 ms Pauses	79	1.03	.31	1.34	.25	7.74	.01*	.24	.63	.87	.35	.00	.97	1.66	.20
F0 Mean	79	.48	.49	.08	.78	1.18	.28	.11	.74	.98	.33	.10	.75	1.56	.22
F0 SD Local	71	.00	.96	2.07	.16	.21	.65	6.58	.01*	.13	.72	.09	.77	.46	.50
F0 SD Global	71	.04	.84	.07	.79	.22	.64	2.15	.15	.03	.86	.97	.33	.74	.39
F0 Slope Mean	71	.21	.65	5.93	.02*	.00	.95	.20	.65	.05	.82	.04	.84	.20	.66
F0 Peturbation	79	.03	.86	.03	.86	.39	.54	.10	.75	1.89	.17	2.33	.13	.43	.52
F1 Mean	79	3.11	*.08*	1.70	.20	2.60	.11	1.29	.26	1.25	.27	.07	.79	.27	.61
F1 SD Local	71	.23	.64	1.31	.26	2.77	*.10*	.02	.89	2.90	*.09*	1.81	.18	.05	.83

(table continues)

CANS Variable	*n*	Group		Valence		Arousal		Group x Valence		Group x Arousal		Valence x Arousal		Group x Valence x Arousal	
		F	*p*	*F*	*p*	*F*	*p*	*F*	*p*	*F*	*p*	*F*	*p*	*F*	*p*
F1 SD Global	71	.36	.55	1.75	.19	4.06	.05*	.68	.41	.05	.82	1.67	.20	.11	.75
F1 Slope Mean	71	1.02	.32	.21	.65	.06	.81	.48	.49	2.00	.16	4.38	.04*	.83	.36
F2 Mean	79	2.62	.11	3.31	*.07*	2.79	*.10*	.06	.81	.12	.73	2.25	.14	.13	.72
F2 SD Local	71	.01	.92	.52	.47	2.09	.15	5.40	.02*	.14	.71	1.74	.19	.06	.80
F2 SD Global	71	.01	.91	4.25	.04*	8.60	.01*	.05	.83	.14	.71	.13	.72	.08	.77
F2 Slope Mean	71	.70	.41	.33	.57	.03	.87	.49	.49	3.28	*.08*	1.40	.24	.52	.48
Intensity Mean	79	.91	.34	1.27	.26	12.23	.001**	.04	.85	.00	.95	.02	.88	.35	.56
Intensity SD Local	71	.08	.78	10.42	.001**	4.86	.03*	.01	.93	.04	.84	1.44	.23	.11	.74
Intensity SD Global	71	.30	.59	20.36	.001**	.85	.36	.32	.57	.10	.76	.31	.58	.19	.66
Intensity Slope Mean	71	3.19	*.08*	.22	.64	2.50	.12	.22	.64	.08	.78	.01	.92	.00	.97
Intensity Peturbation	79	.05	.83	.52	.47	4.24	.04*	.01	.92	.06	.81	.54	.47	.02	.90

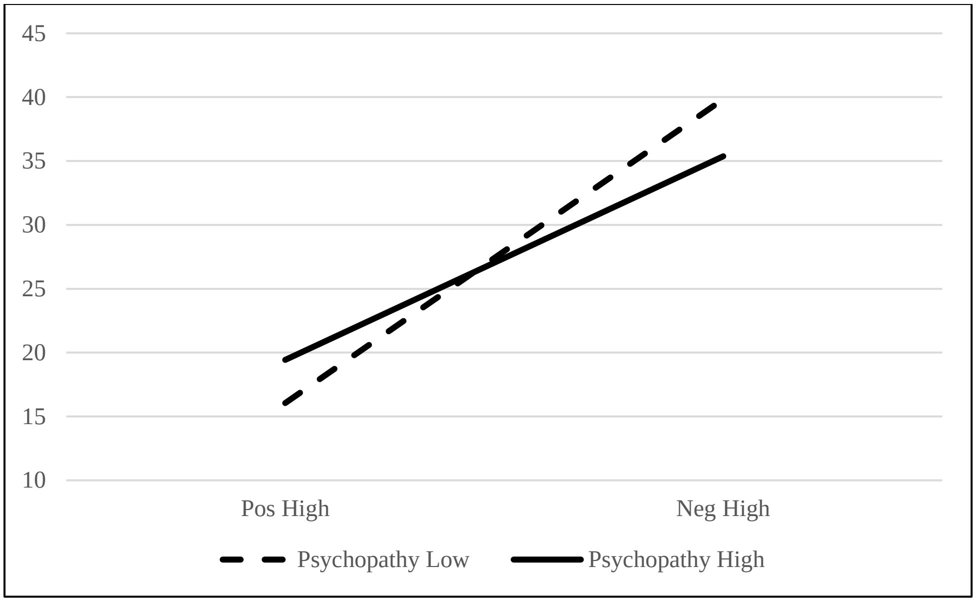

Figure 1. Group by valence interactions for silence percent within high arousal condition.

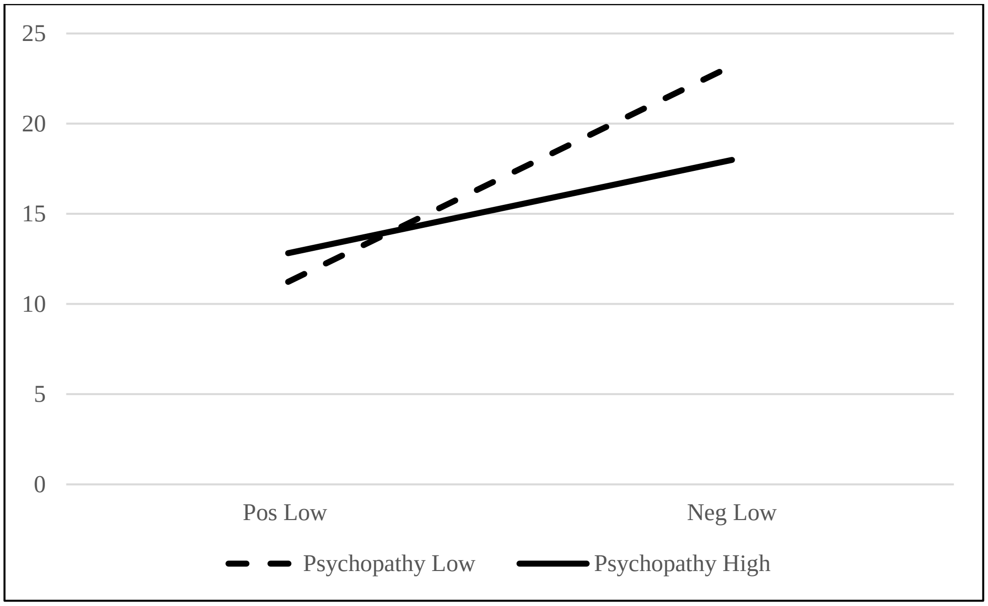

Figure 2. Group by valence interactions for silence percent within low arousal condition.

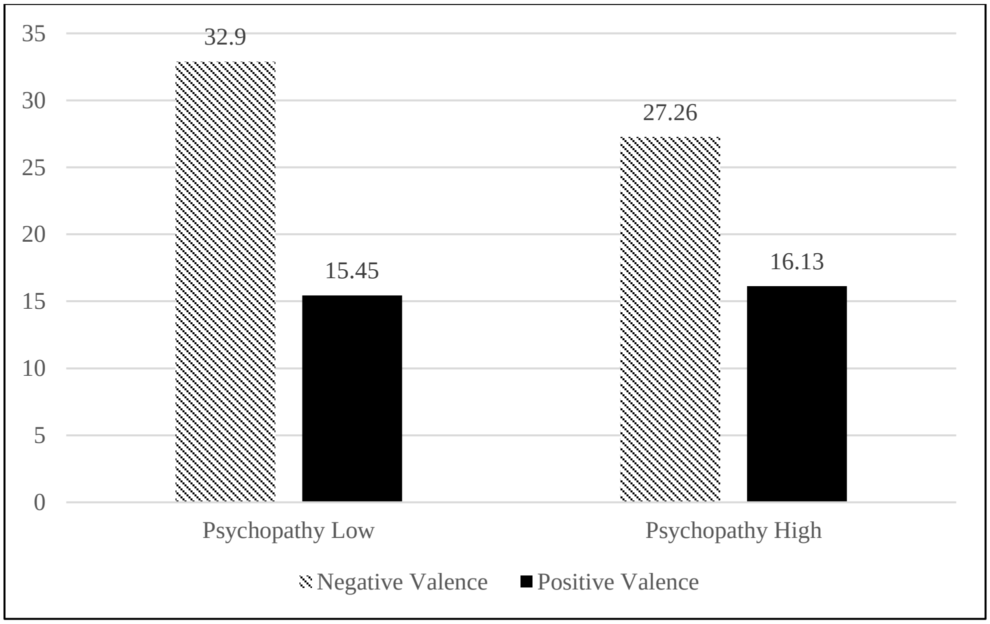

Figure 3. Group by valence breakdown analysis for silence percent.

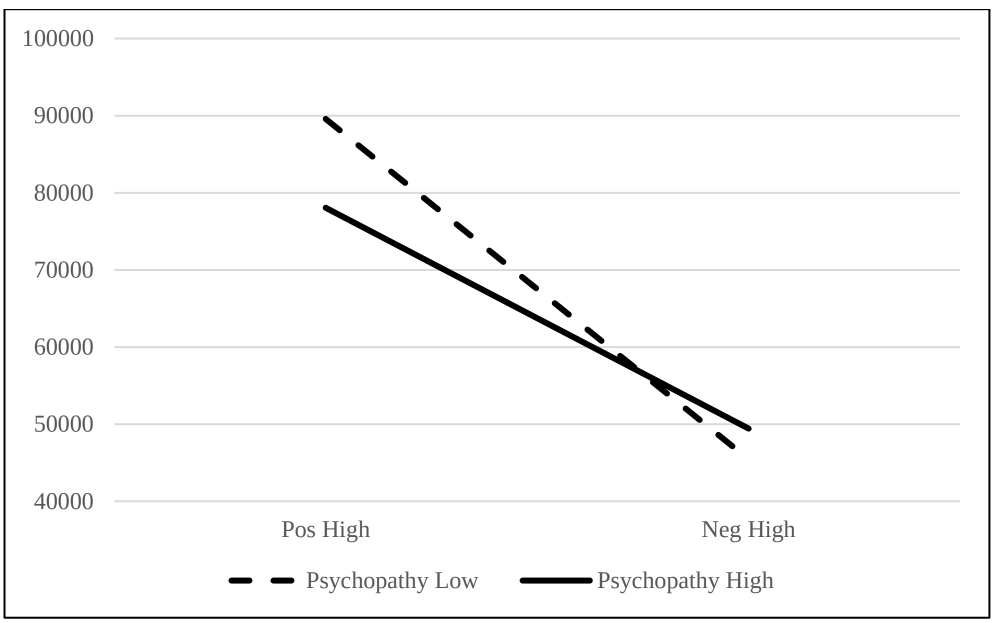

Figure 4. Group by valence interactions for longest pause within high arousal condition.

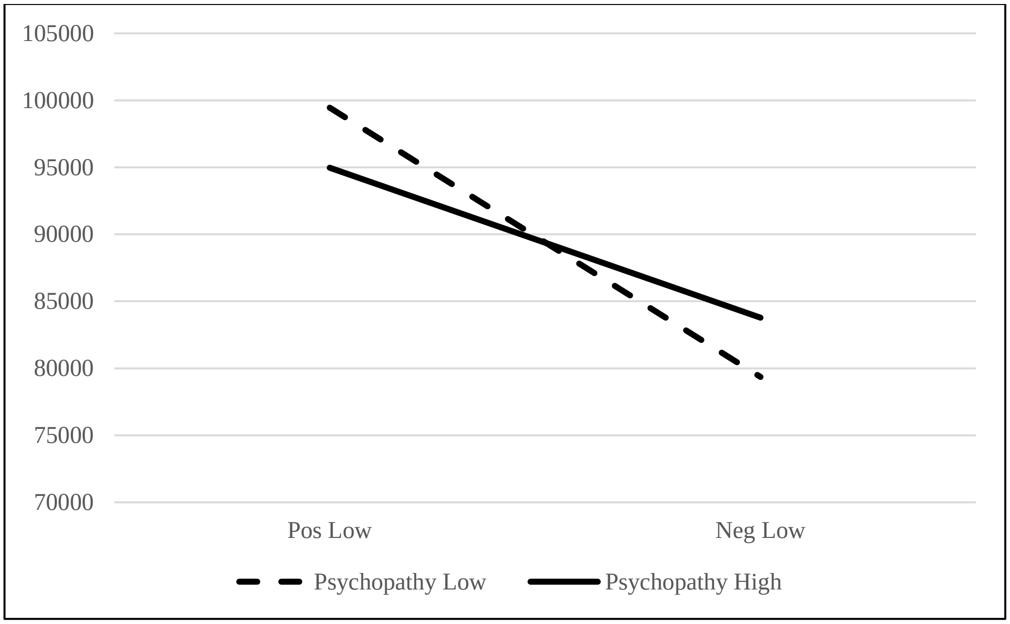

Figure 5. Group by valence interactions for longest pause within low arousal condition.

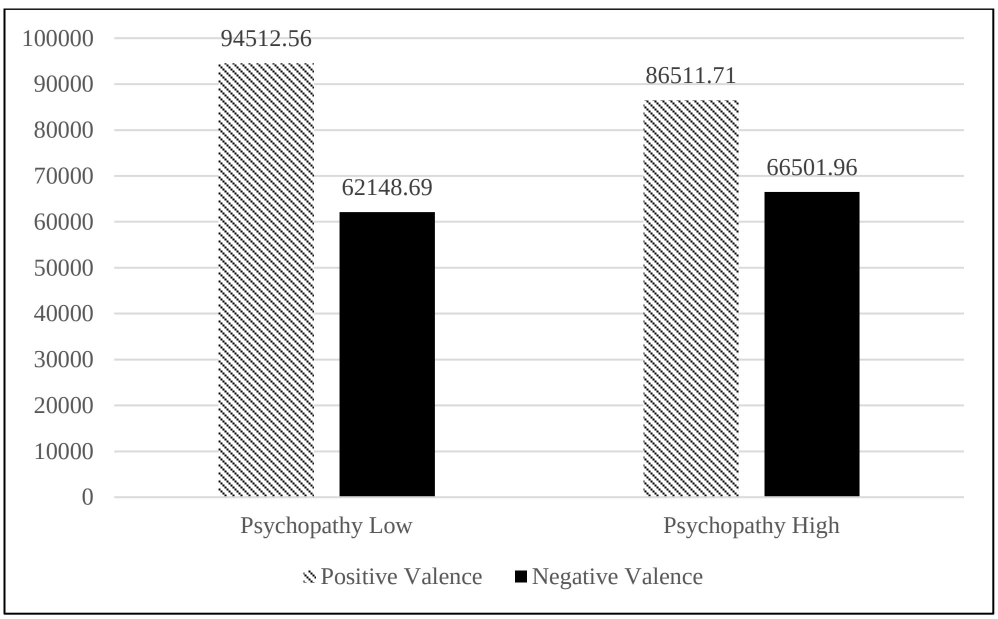

Figure 6. Group by valence breakdown analysis for longest pause.

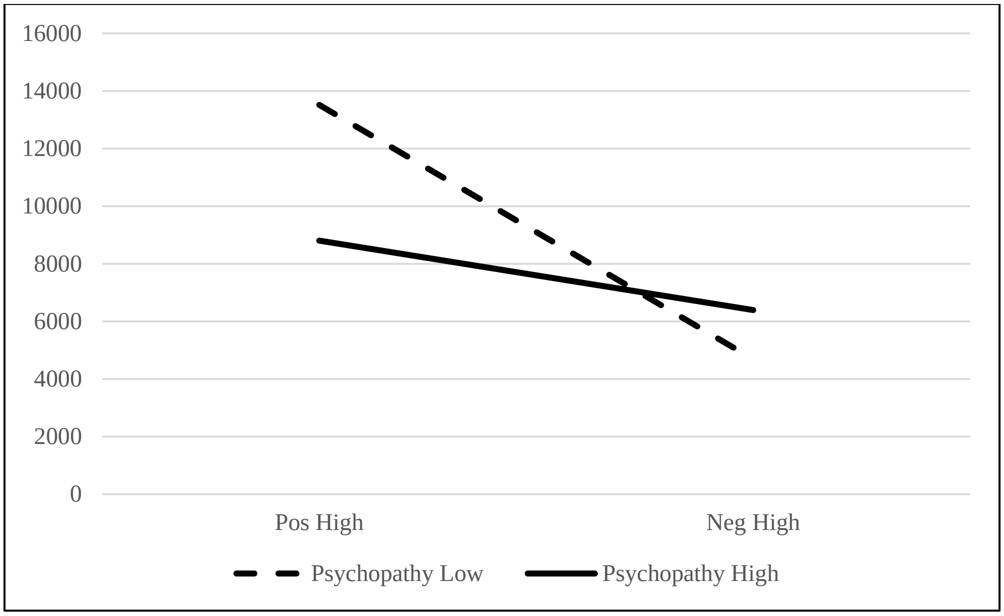

Figure 7. Group by valence interactions for average pause length within high arousal condition.

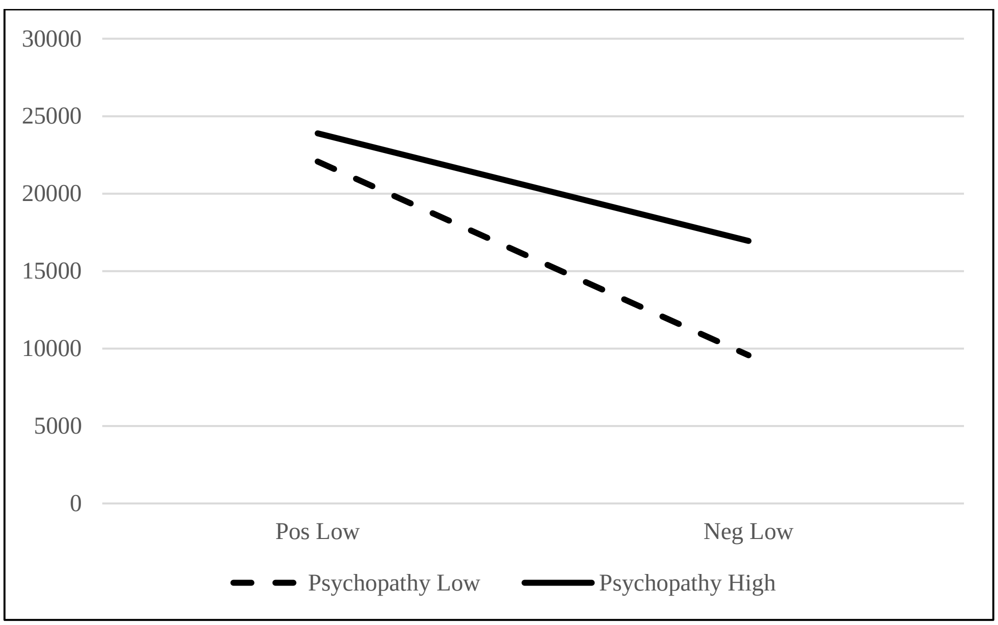

Figure 8. Group by valence interactions for average pause length within low arousal condition.

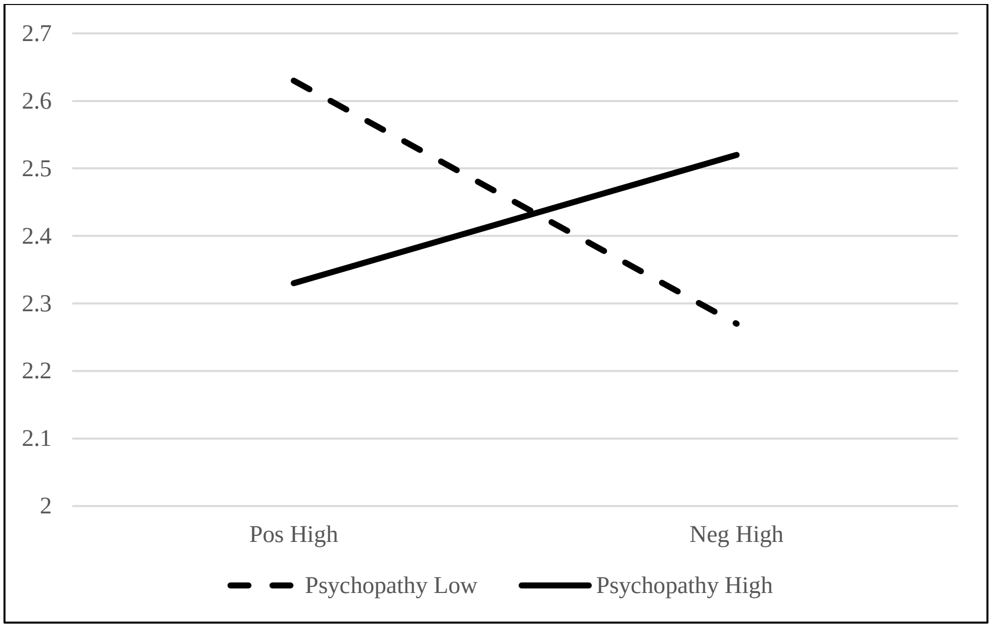

Figure 9. Group by valence interactions for fundamental frequency (F0) SD local within high arousal condition.

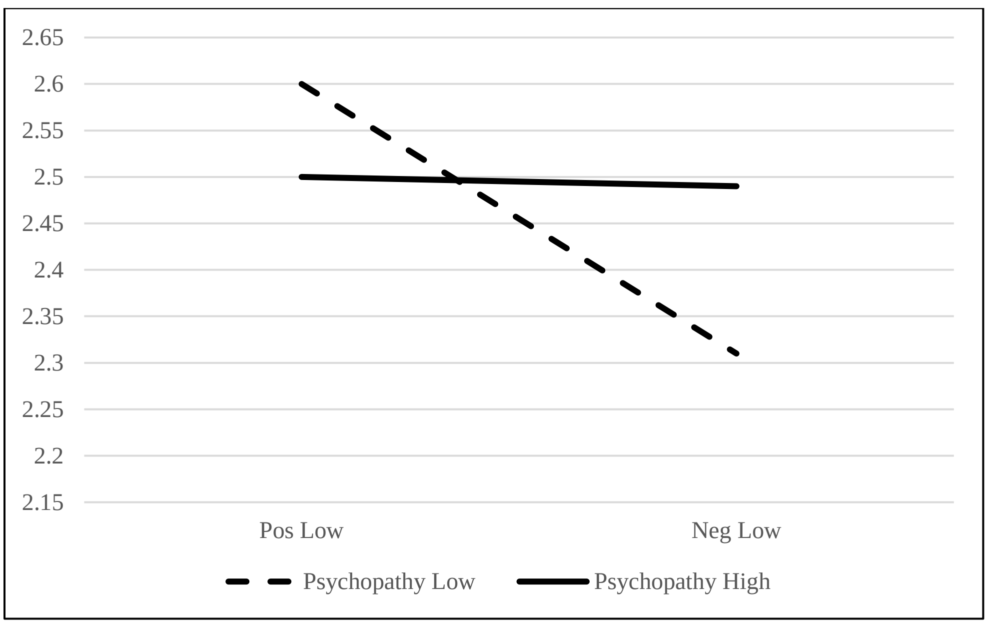

Figure 10. Group by valence interactions for fundamental frequency (f0) sd local within low arousal condition.

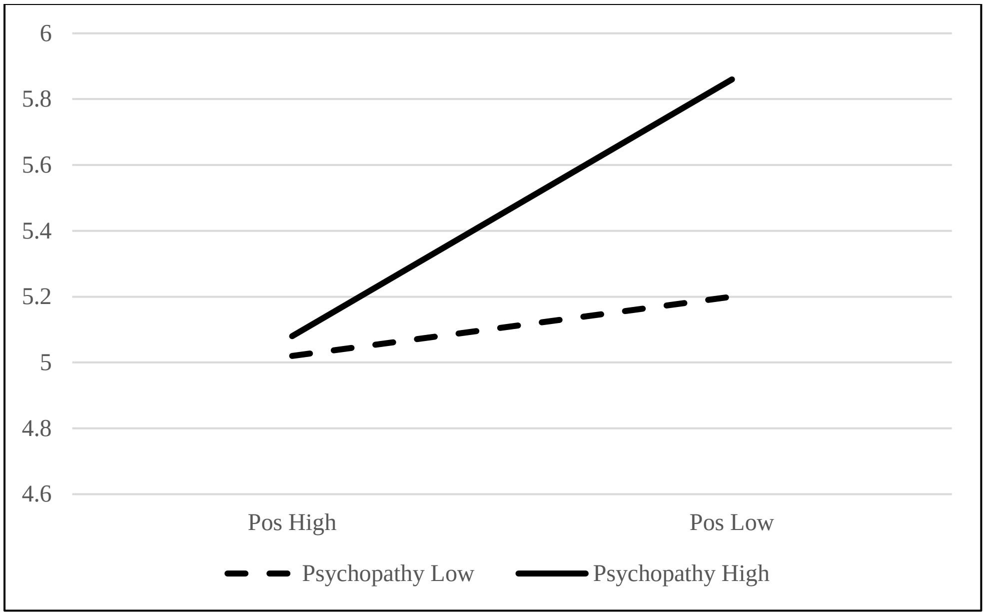

Figure 11. Group by arousal interactions for first format frequency (f1) sd local within positive valence condition.

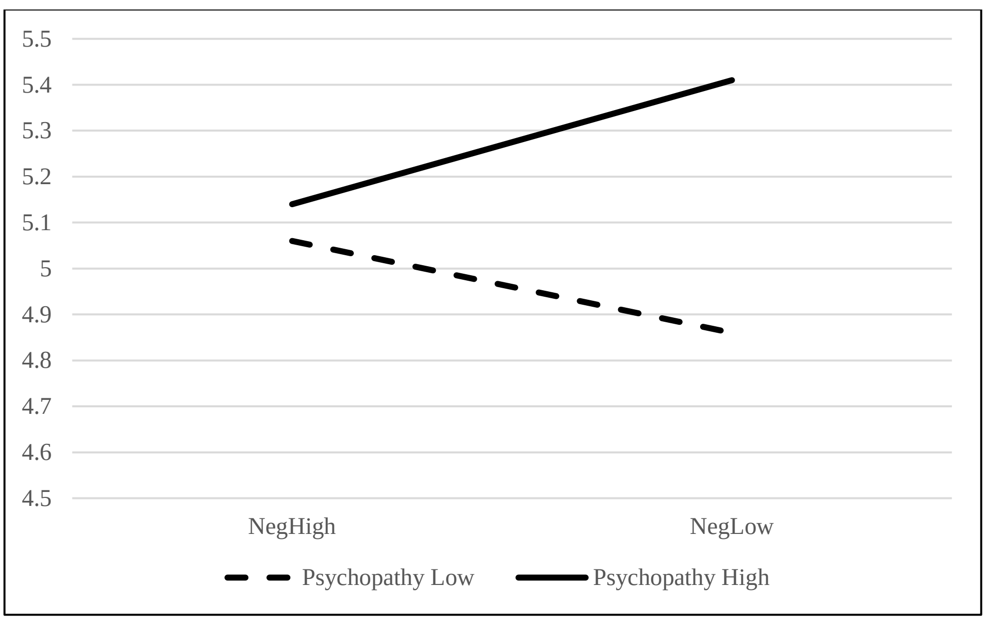

Figure 12. Group by arousal interactions for first format frequency (f1) sd local within negative valence condition.

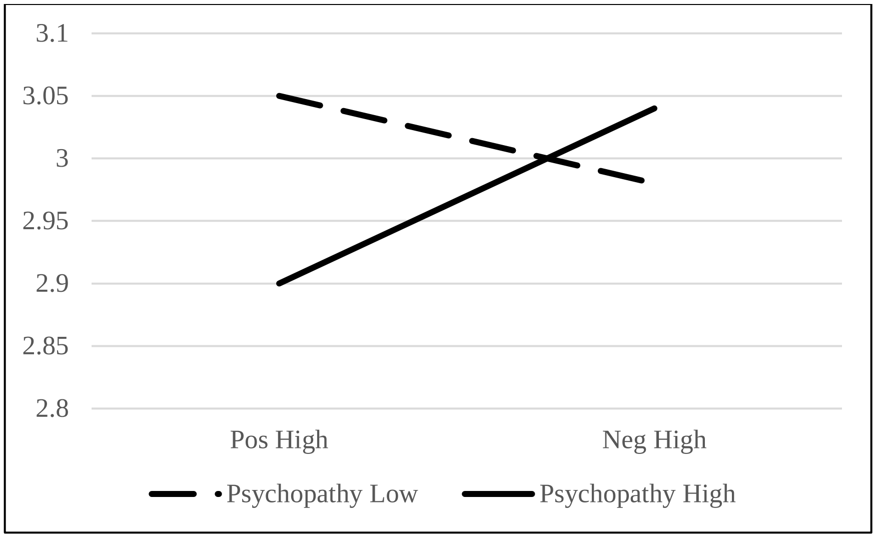

Figure 13. Group by valence interactions for second format frequency (f2) sd local within high arousal condition.

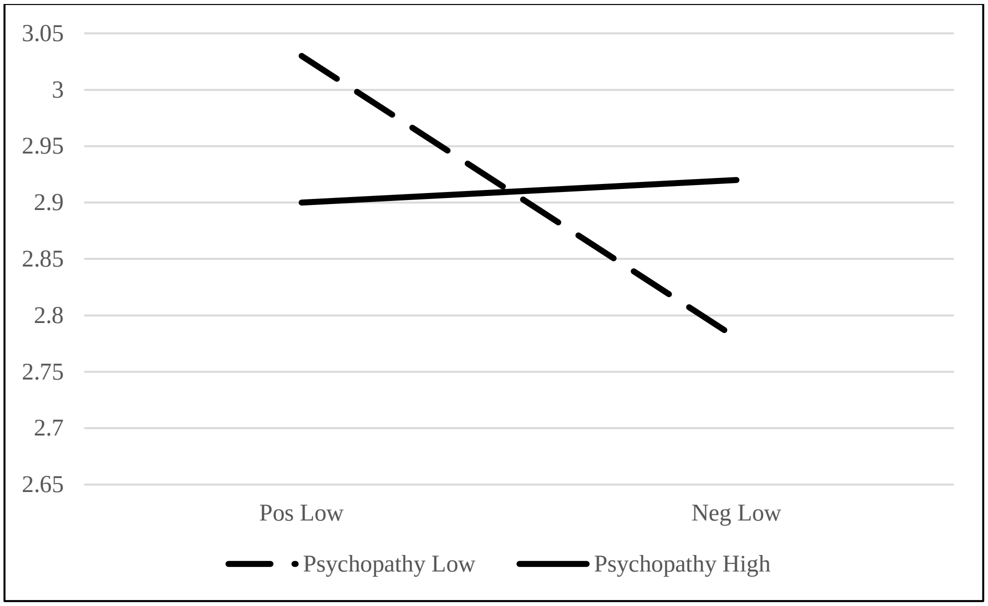

Figure 14. Group by valence interactions for second format frequency (f2) sd local within low arousal condition.

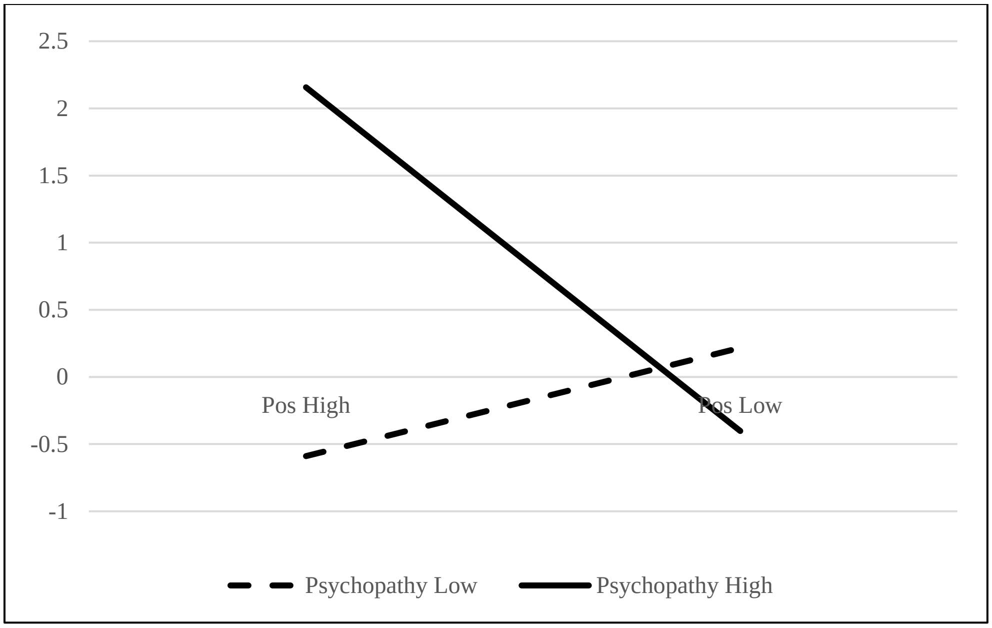

Figure 15. Group by arousal interactions for second format frequency (f2) slope mean within positive valence condition.

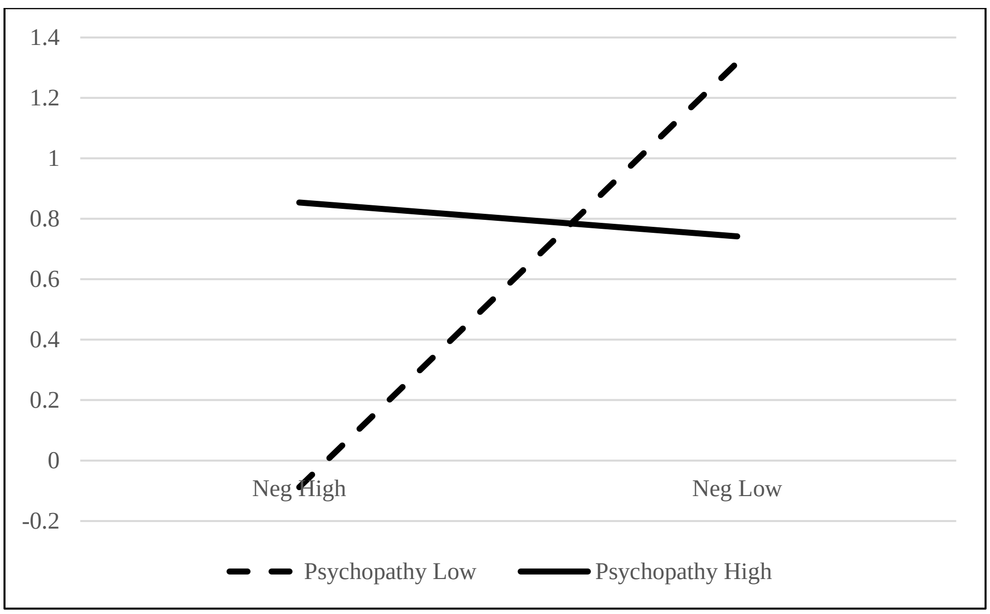

Figure 16. Group by arousal interactions for second format frequency (f2) slope mean within negative valence condition.

APPENDIX A

ACOUSTIC ANALYSIS TRAINING PROTOCOL

Acoustic Analysis Processing Training Protocol

OVERALL RATIONALE – In this project, incarcerated offenders with and without psychopathic personality traits were asked a series of questions as part of a structured interview (i.e., the PCL-R). Their responses were recorded. We will analyze these offenders' speech patterns. These recordings must be processed in order for us to analyze them. Your task will be to employ a software program ("WavePad") to isolate a specific portion of the recordings.

PROBES OF INTEREST – This project will focus on speech from the following 6 probes from the audio recorded structured interview.

1. **pos_high**: What do you think love is or what do you think love feels like?
2. **pos_low**: What are your main accomplishments?
3. **neutral**: What jobs have you had since the age of 18?
4. **neg_high**: What sorts of things make you angry?
5. **neg_low**: What's the saddest you've ever been?
6. **guilty**: Is there anything you feel especially guilty about, even if it wasn't a crime?

END POINTS – Please stop isolating speech (i.e. do not include any additional participant speech) after interview asks the following probes for each respective condition.

1. **pos_high**: Have you ever had a live-in or marital relationship?
2. **pos_low**: What is your main weakness?
3. **neutral**: What was your favorite job?
4. **neg_high**: Have you ever gotten in physical fights?
5. **neg_low**: Have you ever been depressed?
6. **guilty**: Have you ever violated probation or parole?

TIMELINE OF PROBES OF INTEREST IN PCL-R INTERVIEW – In the SWANC study, PCL-R interviews typically run from approximately 1.5 hours to 2.5 hours. The interviews will be standardized with regards to interviewer probe content after the year 2012 (check the latter half of the participant ID to see year of administration). Make sure you are pulling from participants 2012 and later to ensure standardization of probes & administration!

You may see that some participants have tapes labeled "FILE ID_PCLR_a" and "FILE ID_PCLR_b". The "a" and "b" simply mean that the interview was divided up over two sessions.

The probes of interest will occur in the following sequence in the interview. Keep in mind that the time points are just general timing for each probe – they may (and probably will) vary considerably by participant in terms of timing.

1. Work Experience à **NEUTRAL** (~30 min.)
2. Current Relationships à **POS_HIGH** (~60 min.)
3. Impulsivity/Sensation Seeking à **NEG_HIGH** (~80-90 min.)
4. Affective Experience à **NEG_LOW** (~90 min.)
5. Current Incarceration/Arrest History à **GUILTY** (~115 min.)
6. Self-Perception à **POS_LOW** (end of interview; around 125 min.)

The interview will be divided into the following general sections, which typically follow the same order.

School/Early Childhood (~0 min. – 20 min.)

Family History/Current Relationships with Family (~20 min. – 30 min.)

Work Experience/Long-Term Goals/Financial Concerns (~30 min. – 50 min.)

Current Relationships (Children, Romantic, Friends) (~50 min. – 75 min.)

Sex History (~75 min. – 80 min.)

Substance Use (~80 min. – 90 min.)

Impulsivity/Sensation Seeking (90 min. – 100 min.)

Affective Experience (100 min. – 110 min.)

Current Incarceration + Arrest History (110 min – 125 min.)

Self-Perception (125 min. – 130ish min.)

IMPORTANT SHORTCUTS IN WAVEPAD

Play – F9

Stop – Esc

Rewind – Left arrow key

Fast Forward – Right arrow key

Start Over – Home

Play slow speed – F11

Play normal speed – F10

Save As - Ctrl s

New File – Ctrl n

Open File – ctrl o

Keeping Track of Recordings

The Excel spreadsheet titled **Walsh_Thesis_Audio Splicing Tracking** will reflect which audio files are assigned to each person. Please enter your initials under each probe across the row of the audio file (i.e. Pos_High, Pos_Low, etc.) as you complete that probe of that audio file (labeled in the column next to your name). As soon as you enter your initials into a cell, you are responsible for that recording, and ensuring it is completed and correct.

Isolating Subject Speech Samples

Our general goal is to isolate subjects' speech from a recorded interview during the speaking tasks of the previously specified probes. Each probe should have its own file. To do this, follow a six-step process for each file:

1) It is important that you never modify the original speech sample. We need to make sure we have the original on file, so **never touch** the folder named "Original Files- Do Not Edit".
2) Open your assigned file "participantID_fullPCL-R_a or b" by first opening the "**WavePad Sound Editor**" software, and then selecting "**open file**" on the top left.
   - The full PCL-R interviews are ***<u>never</u>*** to be edited
   - To find your file, please go to:
     - "My Computer Drive C" à "HWTHESIS" à STEP1:Full PCL-R Interviews
3) Listen to the interview and each time the interviewer presents a new prompt (this will be indicated by a regular and fairly obvious prompt) drop a bookmark before the presentation of the new prompt. Approximate time stamps for each prompt can be found in the above table.
   - There is no anticipated time allowance for each prompt so you'll have to listen carefully to the whole interview instead of just skipping around in WavePad.
4) Once you have identified the six prompts within the audio file using bookmarks you will "splice out", or isolate them from the entire interview.
   - You do this by first selecting **NEW FILE** in the toolbar.

- After you have opened a new file, drag your cursor across the bookmarks indicating where the segment of speech is. Then, select **COPY** and **PASTE** the isolated segment to the new blank file.
    - Make sure you keep the ***default settings*** for audio when pasting to new file.
- Once you have one probe of interest isolated please save the probe in the folder **STEP 2: ISOLATED PROBES – Save unedited here.**
- Please note in the **Walsh_Thesis_Audio Splicing Tracking** Excel sheet that you have saved the probe by initialing the box for that probe. (i.e. if you've isolated and saved Pos_High you would initial in the column for Pos_High Isolated).
- Please isolate and save all of the probes of interest for that file before moving on to editing our interviewer speech for any of them (step 5).

5) Edit the file containing speech relevant to probes of interest to isolate subject speech and delete the interviewer speech. Please see the Editing Speech section.
    - Delete the prompt by the interviewer (e.g., "What is the most depressed you have ever been?") but keep the pause before the subject responds.
    - Delete any interviewer speech that do not have to do with the probes of interest.
        - This includes interviewer utterances & tokens.
        - See below for definitions of utterances and tokens
6) Once you have completely removed interviewer speech, you will save the file. Please see the Saving File section below.

Editing Speech

In order to analyze subject speech, we need to ensure that only the subjects voice is in the recording. That means we will have to digitally remove all instances of other speech (i.e., the interviewer). There should be limited interviewer speech on the second task of each recording; nonetheless, we need to listen to the recording to remove any instances that may occur.

There are two types of interviewer speech that we are concerned with—utterances and tokens (which don't fully count as utterances). The difference between utterances and tokens will be important in determining what to do with the pauses between speech.

- **Utterances**:
    - We are defining an "utterance" as a segment of speech bounded by the other speaker. It begins exactly when the other individual has stopped talking, and it ends exactly before the pause preceding the other speaker's utterance.
    - An utterance must be more than 1 word long and 1 second or longer. It must occur when the other speaker is not talking.
    - If speech by the interviewer qualifies as an utterance, you will delete the interviewer's utterance and the pause before that utterance (but not after).
- **Token**
    - A "Token" is short speech (e.g., "uh-huh", "yeah", "sure") that does not count as an utterance on its own. It can occur when the other person is speaking or not.
    - If speech by the interviewer does not qualify as an utterance (i.e., if it is only "token" speech), delete only the speech itself, but not the pauses on either side.

How to delete interviewer speech:

- To select portions of the text, click and drag your mouse cursor over the region of interest.
- Be precise – to help, you can use the zoom in function to increase the resolution.
- To assist in locating and double-checking the borders of each utterance or token speech for deleting, it is useful to add a single “bookmark” to the file, which you can move along to mark the beginning of each segment. Then, you can stop the audio playback and single click on the moment that ends the segment (a yellow line should appear). You can then highlight the space between these two bookmarks, and playback to double-check the accuracy of the borders of the segment.
    - Note—if the speech segment is longer than what will fit on the current screen, it is often easier to create a second bookmark to note the end of the segment instead of simply placing a temporary marker (i.e., the yellow line), so that it stays in place when you zoom out to highlight the segment. Just be sure to then go back and delete the first bookmark, so that you’re usually only working with one (do this by clicking on “open bookmark list” under the “bookmarks” tab, and deleting the earlier bookmark).
- Once you’ve assured accuracy of the borders of the selected interviewer speech segment, you can highlight this segment using the bookmarks as boundaries and delete the segment. (Remember to include pauses in speech at the beginning of each “utterance.”)

- Once the entire new file is accurate and edited (i.e., there is no interviewer speech left on the file), save and close.

Saving Files

- After you have isolated the probes of interest and edited out the interviewer speech you will save these files based on the participant ID number, valence (_pos, _neg, _neutral, or _guilty), and arousal level of the probe (_high or _low): **IDnumber_valence_arousal**
  - **Ex. of file:** 1234_pos_low
    - **NOTE: It is not necessary to include arousal level in the neutral or guilty conditions. Simply save these as: 1234_guilty; 1234_neutral**
- Save these files in the folder labeled "**Spliced Files Here- Save Here**" under the **OFFENDER2017** project file found in the **HW THESIS** folder.

<u>**** Do not, under any circumstances, edit the original sound file in the Original Files- Do Not Edit folder in any way ****</u>

APPENDIX B

VALENCE AND AROUSAL CODING TRAINING PROTOCOL

Valence and Arousal Coding Training Protocol

OVERALL RATIONALE – In this project, incarcerated offenders with and without psychopathic personality traits were asked a series of questions as part of a structured interview (i.e., the PCL-R). Their responses were recorded. In the first portion of this study, you were asked to isolate six probes of interest from the larger PCL-R interviews. For Part II, your task will be to listen to the now completed, processed probes to determine the offenders' *actual* valence and arousal level in response to the probe based on Affective Norm for English Word (ANEW) dimensional criteria.

WHAT IS VALENCE AND AROUSAL? – Simply put, ***valence*** refers to the emotional content or charge of a word (i.e., positive vs. negative; pleasant vs. unpleasant). For example, a *positively* valenced word might be something like "happy" or "excited", while a *negatively* valenced might be something like "sad" or "angry".

Arousal refers to how the range of excited or aroused the content of a word makes you feel (i.e., ranging from calm to excited).

An example of a *positively valenced, low arousal* word might be something like "calm" or "achieved", while a *positively valenced, high arousal* word might be something like "ecstatic" or "love". An example of a *negatively valenced, low arousal* word might be something like "depressed" or "sad", while a *negatively valenced, high arousal* word might be "angry" or "livid".

PROBES OF INTEREST – This project will focus on speech from the following 6 probes from the audio recorded structured interview.

1. **pos_high**: What do you think love is or what do you think love feels like?
2. **pos_low**: What are your main accomplishments?

3. **neutral**: What jobs have you had since the age of 18?

4. **neg_high**: What sorts of things make you angry?

5. **neg_low**: What's the saddest you've ever been?

6. **guilty**: Is there anything you feel especially guilty about, even if it wasn't a crime?

ANEW DIMENSIONAL NORMS – ANEW rates English words on the basis of valence and arousal on a scale of 1 to 9.

To rate ***valence*** on the basis of this graph, a word would be deemed "positive" (i.e., pleasant) if it had a rating of 7 or higher. A word would be deemed "negative" (i.e., unpleasant) if it had a rating of 3 or below.

To rate ***arousal*** on the basis of this graph, a word would be deemed high arousal if it had a rating of 6 or higher, and low arousal if it had a rating of 4 or lower.

Arating of "5" means completely neutral arousal and valence.

For the purpose of this study, it is important to listen to see if the participants' responses to the probe include the following words. Basically, if the participant appropriately responds to the probe and the probe elicits its' intended emotional response, you would mark it correctly as pos_high, pos_low, etc. If the participant does say these words, please rate them on the SPSS sheet as follows:

Word	Valence Rating	Arousal Rating
Love	9	7
Achievement	8	4
Sad	2	4
Angry	3	7
Guilty	3	5

Additionally, it will be important to rate participants on what we will call "***emotional contamination***" (i.e., responding in the opposite emotional direction that the probe is asking for). For example, if a participant is asked to define love and instead talks about how much he hates his ex-wife, the participant is responding in the negative valence, high arousal direction rather than the positive valence, high arousal direction.

For the "*Neutral*" probe, you will basically just need to check to make sure that talking about their former jobs does not elicit any strong emotional reaction. You want to make sure that they are basically just listing jobs.

It will also be important to code for participants refusing to answer specific probes. This is particularly relevant for the "guilty" and "pos_low" probes. If a participant says "no" or refuses to answer a specific probe or says they cannot generate a response, code the valence and arousal of the sample as "999".

REFERENCES

Arieti, S. (1963). Psychopathic personality: Some views on its psychopathology and psychodynamics. *Comprehensive Psychiatry, 4*, 301–312. http://dx.doi.org/10.1016/S0010-440X(63)80056-5

Bagley, A.D., Abramowitz, C.S., & Kosson, D.S. (2009). Vocal affect recognition and psychopathy: Converging findings across traditional and cluster analytic approaches to assessing the construct. *Journal of Abnormal Psychology*, 118(2), 388 – 398. doi: 10.1037/a0015372

Barch, D.M. & Berenbaum, H. (1994). The relationship between information processing and language production. *Journal of Abnormal Psychology*, 103, 241–250.

Baskin-Sommers, A. R., Neumann, C. S., Cope, L. M., & Kiehl, K. A. (2016). Latent-variable modeling of brain gray-matter volume and psychopathy in incarcerated offenders. *Journal of Abnormal Psychology, 125*(6), 811.

Batliner, A., Steidl, S., Hacker, C., & Nöth, E. (2008). Private emotions versus social interaction: A data-driven approach towards analysing emotion in speech. *User Modeling and User-Adapted Interaction, 18*, 175–206. doi:10.1007/s11257-007-9039-4

Beck, A.T., Freeman, A., & Davis, D.D. (2004). *The cognitive therapy of personality disorders*. New York: Guilford.

Blair, R. R., Mitchell, D. V., Richell, R. A., Kelly, S., Leonard, A., Newman, C., & Scott, S. K. (2002). Turning a deaf ear to fear: Impaired recognition of vocal affect in psychopathic individuals. *Journal of Abnormal Psychology*, *111*(4), 682-686. doi:10.1037/0021-843X.111.4.682

Blair, K. S., Richell, R. A., Mitchell, D. V., Leonard, A., Morton, J., & Blair, R. R. (2006). They know the words, but not the music: Affective and semantic priming in individuals with psychopathy. *Biological Psychology*, *73*(2), 114-123. doi:10.1016/j.biopsycho.2005.12.006

Boersma, P. (2001). Praat, a system for doing phonetics by computer. *Glot International*, 5, 341-345.

Bradley, M. M., & Lang, P. J. (1999). *Affective Norms for English Words (ANEW): Stimuli, instruction manual, and affective ratings* (Tech. Report C-1). Gainesville: University of Florida, Center for Re- search in Psychophysiology.

Brites, J. D. (2016). The language of psychopaths: A systematic review. *Aggression and Violent Behavior*, 27, 50-54. doi:10.1016/j.avb.2016.02.009

Cleckley H. 1941. *The mask of sanity*. St. Louis, MO: Mosby

Cleckley H. 1976. *The mask of sanity* (5th ed.). St. Louis, MO: Mosby.

Cohen, A. S., Alpert, M., Nienow, T. M., Dinzeo, T. J., & Docherty, N. M. (2008). Computerized measurement of negative symptoms in schizophrenia. *Journal of Psychiatric Research*, *42*(10), 827-836. doi:10.1016/j.jpsychires.2007.08.008

Cohen, A. S., Auster, T. L., McGovern, J. E., & MacAulay, R. K. (2014). The normalities and abnormalities associated with speech in psychometrically-defined schizotypy. *Schizophrenia Research*, *160*(1-3), 169-172. doi:10.1016/j.schres.2014.09.044

Cohen, A. S., Dinzeo, T. J., Donovan, N. J., Brown, C. E., & Morrison, S. C. (2015). Vocal acoustic analysis as a biometric indicator of information processing: Implications for neurological and psychiatric disorders. *Psychiatry Research*, *226*, 235–241. doi:10.1016/j. psychres.2014.12.054

Cohen, A. S., & Docherty, N. M. (2005). Effects of positive affect on speech disorder in schizophrenia. *Journal of Nervous and Mental Disease*, *193*(12), 839-842. doi:10.1097/01.nmd.0000188963.16870.27

Cohen, A.S., Kim, Y., & Najolia, G.M. (2013). Psychiatric symptom versus neurocognitive correlates of diminished expressivity in schizophrenia and mood disorders. *Schizophrenia Research, 146* (1–3), 249–253.

Cohen, A. S., Hong, S. L., & Guevara, A. (2010). Understanding emotional expression using prosodic analysis of natural speech: Refining the methodology. *Journal of Behavioral Therapy and Experimental Psychiatry, 41*, 150-157. doi:10.1016/j.jbtep.2009.11.008

Cohen, A.S., Minor, K.S., Baillie, L.E., & Dahir, A.M. (2008). Clarifying the linguistic signature: Measuring personality from natural speech. *Journal of Personality Assessment*, *90*(6), 559-563. doi: 10.1080/00223890802388459

Cohen, A.S., Minor, K.S., Najolia, G.M., & Lee Hong, S. (2009). A laboratory-based procedure for measuring emotional expression from natural speech. *Behavior Research Methods*, *41*, 204–212.

Cohen, A. S., Mitchell, K. R., Docherty, N. M., & Horan, W. P. (2016a). Vocal expression in schizophrenia: Less than meets the ear. *Journal of Abnormal Psychology*, *125*(2), 299-309. doi:10.1037/abn0000136

Cohen, A. S., Mitchell, K. R., & Elvevåg, B. (2014). What do we really know about blunted vocal affect and alogia? A meta-analysis of objective assessments. *Schizophrenia Research*, *159*(2-3), 533-538. doi:10.1016/j.schres.2014.09.013

Cohen, A. S., Renshaw, T. L., Mitchell, K. R., & Kim, Y. (2016b). A psychometric investigation of 'macroscopic' speech measures for clinical and psychological science. *Behavior Research Methods*, *48*(2), 475-486. doi:10.3758/s13428-015-0584-1

de Almeida Brites, J., Ladera, V., Perea, V., & García, R. (2015). Verbal functions in psychopathy. *International Journal of Offender Therapy and Comparative Criminology*, *59*(14), 1536-1549. doi:10.1177/0306624X14545608

Docherty, N.M., Hall, M.J., & Gordinier, S.W. (1998). Affective reactivity of speech in schizophrenia patients and their nonschizophrenic relatives. *Journal of Abnormal Psychology*, *107*, 461–467.

Dolan, M., & Anderson, I. M. (2002). Executive and memory function and its relationship to impulsive aggression in personality disordered offenders and healthy controls. *Journal of Forensic Psychiatry, 13*(3), 503–526.

Dolan, M., & Fullam, R. (2005). Memory for emotional events in violent offenders with antisocial personality disorder. *Personality and Individual Differences, 38*(7), 1657-1669.

Edens, J. F., Marcus, D. K., Lilienfeld, S. O., & Poythress, N. J. (2006). Psychopathic, not psychopath: Taxometric evidence for the dimensional structure of psychopathy. *Journal of Abnormal Psychology, 115*(1), 131-144. doi:10.1037/0021-843X.115.1.131

Edens, J. F., Poythress, N., Lilienfeld, S., & Patrick, C. (2008). A prospective comparison of two measures of psychopathy in the prediction of institutional misconduct. *Behavioral Sciences & the Law*, 26, 529-541.

Fowler, K. A., Lilienfeld, S. O., & Patrick, C. J. (2009). Detecting psychopathy from thin slices of behavior. *Psychological Assessment*, *21*(1), 68-78. doi:10.1037/a0014938

Garofalo, C., & Neumann, C.S. (in press). Psychopathy and emotion regulation: Taking stock and moving forward. In M. DeLisi (Ed.*), Routledge international handbook of psychopathy and crime*. London, UK: Routledge.

Gawda, B. (2010). Syntax of emotional narratives of persons diagnosed with antisocial personality. *Journal of Psycholinguistic Research, 39*(4), 273-283. doi:10.1007/s10936-009-9140-4

Gawda, B. (2013). The emotional lexicon of individuals diagnosed with antisocial personality disorder. *Journal of Psycholinguistic Research, 42*(6), 571-580. doi:10.1007/s10936-012-9237-z

Gendreau, P., Goggin, C., & Smith, P. (2002). Is the PCL-R really the “unparalleled” measure of offender risk? *Criminal Justice and Behavior*, 29, 397-426.

Hancock, J. T., Woodworth, M. T., & Porter, S. (2013). Hungry like the wolf: A word-pattern analysis of the language of psychopaths. *Legal and Criminological Psychology*, *18*(1), 102-114. doi:10.1111/j.2044-8333.2011.02025.x

Hare, R. D. (1985). Checklist for the assessment of psychopathy in criminal populations. In M. H. Ben-Aron, S. J. Hucker, & C. D. Webster (Eds.), *Clinical criminology* (pp. 157-167). University of Toronto, ON: Clarke Institute of Psychiatry.

Hare, R. D. (1991). *The Hare Psychopathy Checklist - Revised*. Toronto, Ontario: Multi-Health Systems.

Hare, R. D. (1993). *Without conscience: The disturbing world of the psychopaths among us*. New York & London: The Guildford Press.

Hare, R. D. (2003). *Manual for the Hare Psychopathy Checklist-Revised*. (2nd ed.). Toronto, Canada: Multi-Health Systems.

Hare, R. D., & Neumann, C. S. (2008). Psychopathy as a clinical and empirical construct. *Annual Review of Clinical Psychology*, 4217-246. doi:10.1146/annurev.clinpsy.3.022806.091452

Hare, R. D., & Neumann, C. S. (2010). The role of antisociality in the psychopathy construct: Comment on Skeem and Cooke (2010). *Psychological Assessment, 22*(2), 446-454. doi:10.1037/a0013635

Hare, R.D., Williamson, S.E., & Harpur, T.J. (1988). Psychopathy and language. In Moffitt, T.E., Sarnoff, A.M. (Eds.), *Biological contributions to crime causation* (pp. 68-92). NATO Advanced Science Series D: Behavior and Social Sciences. Martinus Nishoff Publishing, Dordrecht, The Netherlands.

Hervé, H. (2007). Psychopathic subtypes: Historical and contemporary perspectives. In J. C. Yuille & H. Hervé (Eds.), *The psychopath: Theory, research, and practice* (pp. 431–460). Mahwah, NJ: Erlbaum.

Hoppenbrouwers, S. S., Neumann, C. S., Lewis, J., & Johansson, P. (2015). A latent variable analysis of the Psychopathy Checklist–Revised and behavioral inhibition system/behavioral activation system factors in North American and Swedish offenders. *Personality Disorders: Theory, Research, and Treatment, 6*(3), 251.

Junghaenel, D.U., Smyth, J.M., & Santner, L. (2008). Linguistic dimensions of psychopathology: A quantitative analysis. *Journal of Social and Clinical Psychology, 27*(1), 36-55.

Karpman, B. (1955). Criminal psychodynamics: A platform. *Archives of Criminal Psychodynamics, 1*, 3-100.

Kent, R. D., & Kim, Y. J. (2003). Toward an acoustic typology of motor speech disorders. *Clinical Linguistics and Phonetics, 17*, 427–445. doi:10.1080/0269920031000086248

Kiehl, K. A. (2006). A cognitive neuroscience perspective on psychopathy: Evidence for paralimbic system dysfunction. *Psychiatry Research*, *142*(2-3), 107-128. doi:10.1016/j.psychres.2005.09.013

Kiehl, K. A., Hare, R. D., McDonald, J. J., & Brink, J. (1999). Semantic and affective processing in psychopaths: An event-related potential (ERP) study. *Psychophysiology*, 36, 765-774. http://dx.doi.org/10.1111/1469-8986.3660765.

Kiehl, K.A. & Hoffman, M.B. (2011). The criminal psychopath: History, neuroscience, treatment, and economics. *Jurimetrics*, *51*, 355-397.

Klaver, J.R., Lee, Z., & Hart, S.D. (2007). Psychopathy and nonverbal indicators of deception in offenders. *Law and Human Behavior, 31*, 337-351. doi: 10.1007/s10979-006-9063-7

Krstic, S., Neumann, C. S., Roy, S., Robertson, C. A., Knight, R. A., & Hare, R. D. (2017). Using latent variable- and person-centered approaches to examine the role of psychopathic traits in sex offenders. *Personality disorders: Theory, research, and treatment*. Advance online publication. http://dx.doi.org/10.1037/per0000249

Lawing, K., Frick, P.J., & Cruise, K.R. (2010). Differences in offending patterns between adolescent sex offenders high or low in callous-unemotional traits. *Psychological Assessment*, *22*(2), 298-305.

Lee, C.H., Kim, K., Young, S.S., & Chung, C.K. (2007). The relations between personality and language use. *Journal of General Psychology*, *134*(4), 405-413.

Leistico, A., Salekin, R., DeCoster, J., & Rogers, R. (2008). A large-scale meta-analysis relating the Hare measures of psychopathy to antisocial conduct. *Law and Human Behavior*, *32*, 28–45.

Lorenz, A.R. & Newman, J.P. (2002). Deficient response modulation and emotion processing in low-anxious Caucasian psychopathic offenders: results from a lexical decision task. *Emotion*, *2*, 91-104.

Louth, S. M., Hare, R. D., & Linden, W. (1998). Psychopathy and alexithymia in female offenders. *Canadian Journal of Behavioural Science / Revue Canadienne Des Sciences Du Comportement*, *30*(2), 91-98. doi:10.1037/h0085809

Louth, S. M., Williamson, S., Alpert, M., Pouget, E. R., & Hare, R. D. (1998). Acoustic distinctions in the speech of male psychopaths. *Journal of Psycholinguistic Research, 27*, 375-383. doi:0090-6905/98/0500-0375.

Magyar, M.S., Edens, J.F., Lilienfeld, S.O., Douglas, K.S., & Poythress, N.G. (2011). Examining the relationship among substance abuse, negative emotionality and impulsivity across subtypes of antisocial and psychopathic substance abusers. *Journal of Criminal Justice*, 39, 232-237.

Marsh, A. A., Finger, E. C., Fowler, K. A., Adalio, C. J., Jurkowitz, I. N., Schechter, J. C., & ... Blair, R. R. (2013). Empathic responsiveness in amygdala and anterior cingulate cortex in youths with psychopathic traits. *Journal of Child Psychology and Psychiatry*, *54*(8), 900-910. doi:10.1111/jcpp.12063

Minor, K. S., Luther, L., Auster, T. L., Marggraf, M. P., & Cohen, A. S. (2015). Category fluency in psychometric schizotypy: How altering emotional valence and cognitive load affects performance. *Cognitive Neuropsychiatry*, *20*(6), 542-550. doi:10.1080/13546805.2015.1116441

Mokros, A., Hare, R. D., Neumann, C.S., Santilla, P., Habermeyer, E., & Nitschke, J. (2015). Variants of psychopathy in adult male offenders: A latent profile analysis. *Journal of Abnormal Psychology*, *124* (2), 372-386.

Neumann, C. S., Hare, R. D., & Newman, J. P. (2007). The super-ordinate nature of the Psychopathy Checklist-Revised. *Journal of Personality Disorders*, 21(2), 102-117. doi:10.1521/pedi.2007.21.2.102

Neumann, C.S. & Hare, R.D. (2008). Psychopathic traits in a large community sample: Links to violence, alcohol use, and intelligence. *Journal of Consulting and Clinical Psychology, 76*(5), 893-899.

Neumann, C.S., Hare, R.D., & Johansson, P.T. (2013). The Psychopathy Checklist-Revised (PCL-R), low anxiety, and fearlessness: A structural equation modeling analysis. *Personality Disorders: Theory, Research, and Treatment, 4*(2), 129-137. doi: 10.1037/a0027886

Neumann, C. S., Vitacco, M. J., & Mokros, A. (2015b). Using both variable-centered and person-centered approaches to understanding psychopathic personality. In *The clinical and forensic assessment of psychopathy: A practitioners guide* (2nd ed.). Mahwah, NJ: Lawrence Erlbaum

Oberlander, J., & Gill, A. J. (2006). Language with character: A stratified corpus comparison of individual differences in e-mail communication. *Discourse Processes*, 42, 239-270.

Olver, M. E., Neumann, C. S., Sewall, L. A., Lewis, K., Hare, R. D., & Wong, S. C. P. (2018). A comprehensive examination of the psychometric properties of the Hare Psychopathy Checklist-Revised in a Canadian multisite sample of indigenous and non-indigenous offenders. *Psychological Assessment*. Advance online publication. http://dx.doi.org/10.1037/pas0000533

Osborne, J.W. (2002). Notes on the use of data transformations. *Practical Assessment, Research, and Evaluation*, *8*(6), 1-7. ISSN:1531-7714.

Pennebaker, J. W., & Beall, S. K. (1986). Confronting a traumatic event: Toward an understanding of inhibition and disease. *Journal of Abnormal Psychology*, *95,* 274-281.

Pennebaker, J. W., & King, L. (1999). Linguistic style: Language use as an individual difference. *Journal of Personality and Social Psychology, 77,* 1296-1312.

Pennebaker, J. W., Mehl, M. R., & Niederhoffer, K. (2003). Psychological aspects of natural language use: Our words, our selves. *Annual Review of Psychology*, *54*, 547-577.

Peters, R. H., Greenbaum, P. E., Edens, J. F., Carter, C. R., & Ortiz, M. M. (1998). Prevalence of DSM-IV substance abuse and dependence disorders among prison inmates. *American Journal of Drug and Alcohol Abuse*, *24,* 573-587.

Robert Hare's Page for the Study of Psychopaths, "Sociopaths", Violent Offenders, Serial Killers... (n.d.). Retrieved February 03, 2017, from http://www.hare.org/

Rude, S. S., Gortner, E. M., & Pennebaker, J. W. (2004). Language use of depressed and depression–vulnerable college students. *Cognition and Emotion*, *18*, 1121-1133.

Quinsey, V.L., Harris, G.E., Rice, M.E., & Cormier C. (2006). *Violent offenders: Appraising and managing risk* (2nd ed.). Washington, DC: American Psychological Association.

Salekin, R. T., Rogers, R., & Sewell, K. W. (1996). A review and meta-analysis of the Psychopathy Checklist and the Psychopathy Checklist–Revised: Predictive validity of dangerousness. *Clinical Psychology: Science and Practice*, *3*, 203-215.

Schachter, S., Christenfeld, N., Ravina,B., & Bilous, F. (1991). Speech disfluency and the structure of knowledge. *Journal of Personality and Social Psychology*, *60,* 362-367.

Stirman, S. W., & Pennebaker, J. W. (2001). Word use in the poetry of suicidal and nonsuicidal poets. *Psychosomatic Medicine*, *63*, 517-522.

Tausczik, Y. R., & Pennebaker, J. W. (2010). The psychological meaning of words: LIWC and computerized text analysis methods. *Journal of Language and Social Psychology*, *29*(1), 24-54. doi:10.1177/0261927X09351676

Thanh, P. L., Najolia, G. M., Minor, K. S., & Cohen, A. S. (2017). The effect of limited cognitive resources on communication disturbances in serious mental illness. *Psychiatry Research*, *248*, 98-104. doi:10.1016/j.psychres.2016.12.025

Tull, M. T., Medaglia, E., & Roemer, L. (2005). An investigation of the construct validity of the 20-Item Toronto Alexithymia Scale through the use of a verbalization task. *Journal of Psychosomatic Research*, *59,* 77-84.

Van Lancker Sidtis, D., Pachana, N., Cummings, J. L., & Sidtis, J. J. (2006). Dysprosodic speech following basal ganglia insult: Toward a conceptual framework for the study of the cerebral representation of prosody. *Brain & Language*, *97*, 135-153.

Vitale, J. E., Brinkley, C. A., Hiatt, K. D., & Newman, J. P. (2007). Abnormal selective attention in female psychopathic offenders. *Neuropsychology, 21*(3), 301-312.

Vitacco, M. J., Neumann, C. S., & Jackson, R. L. (2005). Testing a four-factor model of psychopathy and its association with ethnicity, gender, intelligence, and violence. *Journal of Consulting and Clinical Psychology*, *73*(3), 466-476. doi:10.1037/0022-006X.73.3.466

Williamson, S. E., Harpur, T. J., & Hare, R. D. (1991). Abnormal processing of affective words by psychopaths. *Psychophysiology, 28*, 260–273. http://dx.doi.org/10.1111/ 1469-8986.ep1103072.

Wright, E. M. (2009). The measurement of psychopathy: Dimensional and taxometric approaches. *International Journal of Offender Therapy and Comparative Criminology, 53*(4), 464-481. doi:10.1177/0306624X08319416